Technology Principle Project

Introduction

The community of mathematics educators agree that technology is important in mathematics classrooms. Technology plays a crucial role in NCTM's (2000) vision of an effective learning environment. Without the availability or accessibility of great technologies, though, how can students fulfill this vision? This study focuses on two research questions: What technologies are available to students and/or teachers, and how accessible are they?

Literature Review

Technology has three major roles in the math classroom. It "enhances mathematics learning, it supports effective mathematics teaching, and it influences what mathematics is taught (NCTM, 2000, pp. 25–26)" (McGehee & Griffith, 2004, p. 344).

Technology shifts the students' attention from lower-level algorithms to more complex thinking such as decision-making and problem solving. Approaching a problem by use of investigation, can help students understand it rather than focus on computational abilities to obtain a solution. The use of technology allows students to quickly perform calculations and spend more time on making and testing conjectures about those results (Erbas, Ledford, Polly, & Orrill, 2004). For instance, cutting different paper triangles and measuring the sum of their angles would take a very long time by hand, but with the use of *Geometer's Sketchpad*, this act can take seconds. The students will not need to focus on cutting in straight lines or ensuring their protractors are aligned because the computer does this for them. Rather, they can spend their time noticing patterns and making generalizations about properties of triangles.

Along with helping with calculations, technology allows students to see multiple representations and perspectives of concepts, which helps them think in different ways and develop better understanding (NCTM, 2000; Erbas, Ledford, Polly, & Orrill, 2004). The technology is faster and better at constructing examples and sets of data so that students can analyze and reason inductively about the information (NCTM, 2000). Data analysis applications such as *Microsoft Excel* serve as a good example: When given a constant acceleration due to gravity, students can calculate the velocity and distance of a falling object over the first few seconds by hand, but then use the spreadsheet to calculate the remaining intervals. With this automatic data, students would be able to derive the equations for velocity and distance dependent on time. They can construct their own meaning rather than focus on performing calculations.

NCTM (2000) also says that technology supports effective mathematics teaching. In this context, technology can help teachers decide how to plan lessons and activities. Given a technology and its capabilities, teachers are able to pose questions for their students such that they will use the technology appropriately. For example, when discussing an activity with the *CBR-2*, "What do you do when your walk matches the level part of the graph?" (McGehee & Griffith, 2004, p.345) is a question that helps students think about velocity as slope of the line in a distance-time graph.

Even when students are working in groups or independently, the teacher plays an important role, albeit unseen (NCTM, 2000). The teacher must decide what technologies should be used, and when and how the students should them. Technology does demonstrate multiple representations, but it also promotes different ways of thinking and problem solving, which helps

teachers assess the students' cognitive processes, ultimately affecting teachers' decisions about curriculum.

McGhee & Griffith (2004) conclude that technology implements NCTM's (2000) five content standards as well as the five process standards. The increase in technology yields changes in curriculum and changes in views on which concepts are essential in the classroom. Not only does technology act as a tool that enhances the learning of math, it is also determines the behavior of students and teachers with respect to content. The more (and better) technology that is available, the more students will be able to make decisions, think critically, and focus on meaning.

Methods

Data Collection

The data I collected consists of information on the different technologies available at BHS, how students and teachers can access these technologies, and an example of a particular use or purpose of the technology. I started by interviewing my mentor teacher, Mr. Noble. He told me that the most commonly used technologies in his classroom were the *TI-83* graphing calculator, the *TI-108* four-function calculator, and the *Smart Board*. The calculators were allowed to be used at any time in the classroom, except for the occasional non-calculator portion of a test. The Smart Board was used every day, usually as a document projector or a white board. Students were normally not allowed to use the Smart Board unless the teacher asked them to.

Mr. Noble said that he would welcome the use of more technologies in his classroom, provided he and his coworkers were more familiar with them. For example, I mentioned and demonstrated a bit with *Geometer's Sketchpad* and *TinkerPlots*. He seemed skeptical at first, but said that they might be useful for helping students learn. The only problem was that none of the other teachers in his department had any knowledge of the technologies so they might not be open to using them in their classroom. One item Mr. Noble seemed very fond of was an audience response system; a type of which the *iClicker* brand is widely known. The mathematics department at BHS simply cannot fund new instruments like these or the *TI-Navigator*, which would be just as effective.

I also spoke to one of the school librarians, Ms. Helper, who was in charge of technology in the library. She said there were many technological resources available for checkout by the students and teachers. One of the most popular was the flip cameras, which students would use to create instructional videos (e.g., a student would record a how-to video in Spanish about baking cookies). One of the benefits of the flip cameras is a high degree of assessment. Teachers could use the cameras to record students' presentations and grade them at a more convenient time. Another popular technology Ms. Helper mentioned was the Elmo document projector. The Smart Board would normally be a better substitute, but only if the document is uploaded to the teacher's computer. The document projector is useful for hard copies, toys and hand-held objects (e.g., Dienes Blocks or play-doh), and for teachers who use their fingers to follow along in their readings. There were other common technologies available, such as computer labs (with limited internet access) and DVD collections. The computers at the library could be used freely by the students at any time, and the computer lab classrooms were only accessible to teachers who signed up to bring their classes inside. One thing Ms. Helper said that surprised me was the limited internet access the computers offered. I expected that adult material would be restricted, but what I did not expect was that it was very difficult to gain information having any relationship with liberal agendas. She said students could not conduct research on abortion and witchcraft, to

name a few examples. The network simply did not allow it. I am disappointed that political issues could have such an impeding effect on students' learning. The DVD collections contained informational videos for the students and instructional videos for the teachers. See Figure 1 for a table summarizing the availability and accessibility of technology.

Data Analysis

Technology in Blacksburg High School is readily available and accessible for teachers and students, but not in all classrooms. Every classroom has an LCD projector and Smart Board, and every math classroom has the hand-held graphing calculators. Teachers and students also have access to a multitude of technological resources in the Library.

The availability and accessibility of technology is not sufficient, however. Effective use of technology requires teachers' permissions and time during class to visit the computer labs. Teachers may view this time as time that could have been spent for lecture. Teachers need to be made aware of the advantages of technology and the effective ways of implementing it in the classroom. Another important factor is the teachers' familiarity with a technology. Teachers need to be fluent in the language of the tools they are using and be able to construct and troubleshoot lessons that appropriately use those tools. Becoming fluent in this manner requires collaboration among teachers and professional development.

Results and Conclusions

My data does not quite match up with NCTM's (2000) vision. In a perfect world, all sorts of technology would be at students' disposal, but it is a matter of fact that teachers are most likely unwilling to change tradition and introduce new technologies, especially if they are uncomfortable with them. Those in the mathematics education community should promote awareness of different types of technology and creative ways to implement them in and out of the classroom.

Implications for Future Research

For researchers who wish to continue or expand this study, further research questions have arisen. In particular, I am interested in how Internet access in schools affects the performance of mathematics students. Does the amount of time spent in a school computer lab with Internet access affect overall performance, and if so, how? Is it this time in the lab that affects performance or is it the tools available in the lab? A future study might compare three classrooms: one with no computer access, one with computer access but no Internet access, and one with computer and Internet access, against students' grade averages. Another possibility is to compare classrooms with the same type of accessibility but with differing amounts of time allotted.

Appendix

Technology	How to Access	Example of Use in Classroom
TI-83 Graphing Calculator	Available in front of classroom	Higher-level calculations: geometric mean, trig ratios, radicals
TI-108 Four-Function Calculator	Available in front of classroom	Lower-level calculations: basic operations
LCD Projector	Available in every classroom	Display of any video input
TI-89 Emulator	Software bundled with teacher's computer	Display TI-89 screen and keystrokes
Overhead Transparency Projector	Available in some classrooms, Library	Display of transparencies and translucent marker
SMART Board & SMART Pad	Built into the classroom for teacher	Display computer screen, write notes (as a whiteboard), variable display (e.g., move a figure or change a color), draw perfect lines and polygons
Elmo document projector	Only available in some classrooms, and in Library	Display a hard document on screen, for use when transparencies are not available or unpractical
Flip cameras	Available for check out in Library	Video projects/blogs, how-to videos, methods of assessment
DVDs	Available for check out in Library	Instructional DVDs for teachers, informational DVDs for students
Computer labs	Throughout school	Classroom time in labs, editing software, research projects
Audience Response System	Not yet available	Mass data collection and data analysis for quick classroom polls

Figure 1. Summary of available technology in typical classrooms at Blacksburg High School.

References

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