Investigating the Use of Graphing Technology in Middle School Mathematics

Are We Meeting the TEKS?

A PROPOSAL for a THESIS in MATHEMATICS

by

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Abstract

Technology is an integral part of everyday life in the United States. Strong evidence and compelling statements from professional organizations support the use of calculator and computer technology in the learning cycle of mathematics. Frequent usage of calculators by eighth-graders was associated with higher test scores. Many students have difficulty making connections between different representations in mathematics. Technology can help. Teachers are able to implement technology to serve different purposes. Teachers face challenges in deciding how, when, and to what extent to implement technology. The objective of this research is to investigate how middle school mathematics teachers integrate technology into instruction in an urban school district in south Texas. The outcome of this investigation will lead to an understanding of how technology is being used and what factors are correlated with implementation of technology in mathematics classrooms.
Introduction

Technology is an integral part of everyday life in the United States. In order to prepare students for careers in this high-tech world, the integration of technology is permeating all content areas of the school curricula. One standard from the Texas Essential Knowledge and Skills (TEKS) requires middle school students to use a variety of mathematical tools, including technology. The TEKS are non-negotiable standards the state of Texas requires to be taught. This is spelled out in the introduction to the mathematics TEKS (111.22. Mathematics Grade 6-8).

Throughout mathematics in Grades 6-8, students use these processes together with graphing technology and other mathematical tools such as manipulative materials to develop conceptual understanding and solve problems as they do mathematics. (TEA, 2006, 1).

The middle school standard which requires technology is stated as follows at all three grade levels (TEKS 6.11, 7.13, 8.14).

Underlying processes and mathematical tools. The student applies Grade 6 mathematics to solve problems connected to everyday experiences, investigations in other disciplines, and activities in and outside of school.

The student is expected to:
D) select tools such as real objects, manipulatives, paper/pencil, and technology or techniques such as mental math, estimation, and number sense to solve problems.
(TEA, 2006, 4)

The state requirement for implementing technology in mathematics courses is abundantly clear. However, the middle school Texas Assessment of
Knowledge and Skills (TAKS) test does not assess this standard. An inherent problem in middle school mathematics programs is weaving technology requirements into an overflowing curriculum, the majority of which is tested. The objective of this research is to investigate how middle school teachers integrate graphing technology into mathematics instruction in an urban school district in south Texas. The questions that this investigation will address are:

1. How are middle school mathematics teachers using graphing technology in their classrooms?
2. What teacher factors support or hinder the implementation of graphing technology?
3. What common factors are typical of teachers who are using graphing technology to improve understanding?

Related Work and Justification

There is strong evidence and compelling statements from professional organizations to support the use of technology in the learning cycle of mathematics. The National Council of Teachers of Mathematics (NCTM, 2000) states: "Technology is essential in teaching and learning mathematics; it influences the mathematics that is taught and enhances students' learning." (39) In addition, the National Board of Professional Teaching Standards (NBPTS, 2005) states:

Accomplished mathematics teachers are knowledgeable about and, whenever possible, use current technologies and other resources to promote student learning in mathematics. They select adapt and create engaging instructional materials and draw on human resources from the school and the community to enhance and extend students understanding and use of mathematics. (39)

A meta-analysis of 88 studies on the use of calculators was conducted by Hembree and Dessart (1992). Only one of the studies
reported negative findings on calculator use. The preponderance of research evidence supports the fact that calculator use for instruction and testing enhances learning and the performance of arithmetical concepts and skills, problem solving, and attitudes of students.

Frequent usage of calculators by eighth-graders was associated with higher test scores. Eighth-graders permitted to use calculators on class tests had higher average NAEP scores than those who were not. Unrestricted use of calculators resulted in higher average scores than restricted calculator use (Waits and Demana, 2000). Students who reported using calculators on a daily basis performed well above those who rarely or never used them (TIMSS, 1998).

Many students have difficulty making connections between mathematical expressions and the situations to which they refer. Technology can help. Computers provide a medium in which visual representations can be made dynamic. Geometer Sketchpad and CamMotion are examples of systems that create an environment in which mathematics is an experimental science, in which trying things out and noting what happens is an acceptable—and even preferable—approach (Rubin, 2001).

Teachers are able to implement technology to serve different purposes. Howson and Kahane (1986) suggest two distinct ways teachers can choose to implement technology in the mathematics classroom. The first is to use the computer as a teaching aid; the second is to allow and expect students to interact with the computer. Simmt (1997) suggests teachers' most common reasons for using graphing calculators were to save time and for motivation of
students. In her research, some teachers reported they were able to use a guided-discovery approach because the graphing calculators were available for students. Waits and Demana (2000) suggest a need for a balance between paper-and-pencil and calculator techniques on a regular basis. They provide the following method teachers can use to achieve this balance.

- Solve problems using paper and pencil and then support the results using technology.
- Solve problems using technology and then confirm the results using paper-and-pencil techniques.
- Solve problems for which they choose whether it is most appropriate to use paper-and-pencil techniques, calculator techniques, or a combination of both. (59)

Teachers face challenges in deciding how, when, and to what extent to implement technology. Becker (2001) asserts that a determining factor of whether a teacher uses technology is if she/he has access to computers in her/his own classroom. Additional factors include how the school day is carved up into classes and the extent to which the teacher feels pressure to cover large amounts of curricula. Driscoll (2002) suggests four ways in which technology could be used in classrooms to facilitate learning:

1. Learning occurs in context, including ways that technology can facilitate learning by providing real world contexts that engage learners in solving complex problems and computer simulations that offer contexts for learners to understand complex phenomena.
2. Learning is active, including the use of brainstorming, concept mapping, or visualization software.
3. Learning is social, including software that supports a networked multimedia environment.
4. Learning is reflective, including technologies that promote communication within and outside the classroom (201).
Much research has been completed related to the use of technology in classrooms. A bulk of the research has been focused on high school issues and cost effectiveness of using technology. The author could not find any research on the issue of implementing graphing technology within the district that will be the subject of this research or in South Texas in general.

The questions this research will address are:

1. How are middle school mathematics teachers using graphing technology in their classrooms?
2. What teacher factors support or hinder the implementation of graphing technology?
3. What common factors are typical of teachers who are using graphing technology to improve understanding?

Planned Actions

The research will begin with a survey of all middle school mathematics teachers in one large urban school district during the inservice days in August 2007. Five questions focus on how teachers are using graphing technology in their classrooms. Eight questions focus on teacher factors that could affect the implementation of graphing technology. The remaining questions are about other factors outside teachers' control that could affect the use of graphing technology. Statistical tools will be employed to identify relationships in survey responses. The second stage will be interviewing three mathematics teachers identified by department chairs as strong in integrating graphing technology as well as three who are identified as weak. The goal is to determine what common or uncommon factors these groups of teachers have that affect the integration of graphing technology in their classes.

Timeline
May 29-June 29       Work on the proposal
July 6               Submit proposal to committee members
July 18              Submit IRB proposal
July 19              Proposal defense
July 25              Submit CCISD proposal
August 12-October 1  Conduct research
October 2-November 2  Write thesis
November 5           Submit thesis to committee members
November 26-30       Defense of thesis

End Results Expected

The outcome of this investigation will lead to an understanding of how graphing technology is being used and what factors are correlated with implementation of graphing technology in mathematics classrooms. The results will be shared in the hope to provide insight into decisions such as types of inservice training that the district may choose to provide or other support structures that could enhance the existing programs in order to better equip the middle school mathematic teachers to fulfill the requirements of the TEKS.
References


Appendix
Graphing Technology Survey

INSTRUCTIONS: Please respond to each statement by putting an x in the box.

1. How many years of teaching experience do you have? < 1 | 1-5 | 6-10 | 11-15 | > 15

2. What certification do you hold?

<table>
<thead>
<tr>
<th>Elementary K-4 General</th>
<th>Elementary 4-8 General</th>
<th>Elementary K-8 or I-8 General</th>
<th>Secondary Mathematics</th>
<th>Other, please list</th>
</tr>
</thead>
</table>

3. What is your level of education?

| BA or BS | MA or MS | EdD Or PhD |

4. What course or courses do you teach? (Mark all that apply.)

| Math 6 | Math 7 | Alg. Prep. | Math 8 | Alg. 1 | Other |

5. I have had training for implementing graphing calculators in the following situations. (Mark all that apply.)

| School district inservice | ESC workshops | Conferences | College classes | Self taught |

6. What is the ratio of graphing calculators to students in your classes? 0 | < 1:2 | 1:2 | > 1:2 | 1:1 |

7. How many days per week do your students use calculators in class? 0 | 1 | 2 | 3 | 4 | 5 |

Use the following information to select your answers.

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Undecided</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

8. I am satisfied with the availability of graphing calculators. 1 | 2 | 3 | 4 | 5 |

9. Students should have unlimited access to graphing calculators. 1 | 2 | 3 | 4 | 5 |

10. Students primarily use graphing calculators for computation. 1 | 2 | 3 | 4 | 5 |

11. Students primarily use graphing calculators for graphing. 1 | 2 | 3 | 4 | 5 |

12. Students primarily use graphing calculators for exploring relationships. 1 | 2 | 3 | 4 | 5 |
13. I feel confident in my ability to teach the students the use of the graphing calculator.

14. I feel confident in my ability to instruct other teachers in how to implement graphing calculators into their lessons.

15. Teachers should avoid having students use calculators until they are competent with calculations by hand.

16. I only allow students to use the calculators to check their answers.

17. Students who use calculators in class do not do well on TAKS.

18. I find that students who use graphing technology during investigations have a better understanding of the concept.

19. My students use graphing software on computers in my classroom or in a lab.

20. I feel confident in my ability to teach students how to use graphing software.

21. I feel confident in my ability to instruct other teachers how to use graphing software.

22. My school does not have graphing software for the computers.

23. The school schedule does not allow me time to implement graphing technology.

24. I do not have enough time to plan to include graphing technology in my lessons.

25. I have the flexibility in the scope and sequence to include the use of graphing technology.

Graphing Technology Interview
(These are starter questions. The rest of the questions will arise from the answers that are given to these questions.)

1. What courses do you currently teach?
2. What kind of calculators do you have access to?
3. What is the ratio of students to calculators?
4. What graphing software do you use with your students?
5. Do you use computers in your classroom or do you go to a lab?
6. How often?
7. Describe the training that you feel has benefited you the most.
8. What issues do you feel have limited your ability to implement graphing technology?
9. What is the most important reason you have been successful (or unsuccessful) in implementing graphing technology into your lessons?
10. Describe the learning goals you have using graphing technology with your students?
Informed Consent Form

For research being conducted under the auspices
of Texas A&M University–Corpus Christi

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Principal Investigator: Shere Salinas

The teacher named below hereby gives permission to include their responses to
a survey to be used for the purpose of research.

Participation is voluntary, and refusal to participate will involve no penalty or loss
of benefits to which the teacher is otherwise entitled.

To participate, you must be 18 years of age or older. For questions or more
information, contact Shere Salinas at (361) 549-0465. Inquiry about rights may
be made to Renee Gonzales of the Institutional Review board at (361) 825-5994.

I, ____________________________, give permission for
Shere Salinas to keep a copy of the response to the survey. I understand these
written records will be used to investigate mathematics teachers’ usage of
graphing technology, including their graphing technology knowledge,
understanding, attitudes, and beliefs. I understand that my name and any
personal identification will not be published, and that confidentiality of all records
will be maintained. I understand my participation is voluntary and that I may
withdraw at any time without penalty or loss of benefits.

Signed ___________________________ Date ________________
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Signed ________________________________ Date ________________