



2013 HAWAII UNIVERSITY INTERNATIONAL CONFERENCES
EDUCATION & TECHNOLOGY
MATH & ENGINEERING TECHNOLOGY
JUNE 10TH TO JUNE 12TH
ALA MOANA HOTEL
HONOLULU, HAWAII

RUNNING AT MY PACE I FINISH THE RACE !!!

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In 2000, the National Council of Teachers of Mathematics (NCTM) released Principles and Standards for School Mathematics in which six guiding principles were created to support high-level student achievement in the schools. Two of these guiding principles were Equity and Technology. Equity refers to the ability to give “all students, regardless of their personal characteristics, background, or physical challenges, opportunities to study and support to learn mathematics” while technology refers to how the mathematics is taught and enhances student’s learning (National Council of Teachers of Mathematics, 2000). Using quantitative methods, statistically significant outcomes were revealed, that suggest that the technological tool can promote equity, motivate students and help students to work at their own pace. Consequently, providing greater academic achievement in Algebra.

INTRODUCTION

No Child Left Behind (NCLB, 2001) legislation made educators accountable for students’ proficiency in mathematics based on each state’s individual standards of performance. As a result of this, innovative ways have been devised to enhance student learning of mathematical concepts. In many cases, instructional approaches have turned

to technology to assist with this enormous task. The National Council of Teachers of Mathematics (NCTM, 2000) has endorsed the use of technology for teaching a variety of mathematical content. Technology offers students visual images of mathematical ideas and facilitates in the organization and analyzing of data.

The use of technology in mathematics education aids students in the learning process while also becoming a vehicle for equity. NCTM has recognized technology as an important aspect of the teaching/learning process and identified technology as one of its principles for school mathematics. A plethora of technology tools exist to benefit much of what is taught in schools with varying degrees of success.

The purpose of this study is to determine the effectiveness of technology in helping students learn mathematics. More formerly, the exploration and investigation of whether or not Smartpens assist students in their understanding of mathematical concepts more efficiently and effectively than traditional methods. Moreover, the study analyzes student self-reported responses to pre- and post-surveys after a 4-week technological treatment.

Literature Review

This research study of exploring the use of Smartpens in the mathematical classroom setting is both pioneering and exciting for the field of Mathematics Education. Although the technology is not new, the pedagogy behind the use of the technological tool is innovative. However, several studies exist on the use of technology to teach and motivate (Bangert-Drowns, Kulik, & Kulik, 1985; Becker, 1992; Christmann & Badgett, 2003; FletcherFinn & Gravatt, 1995; Hartley, 1977; C. L. C. Kulik & Kulik, 1991; J. A. Kulik, 2003; Li & Ma, 2010; Ouyang, 1993; Eley, 2008; Slavin & Lake, 2008; Slavi,

Lake, Groff, 2009 ; Rakes, Valentine, McGatha, & Ronau, 2010). Previous research studies came to the conclusion that educational technologies do have a positive effect on student learning. While these previous studies show positive achievement by using technology, they were also criticized for methodology problems and lack of longer treatment periods (Cheung, 2013).

Clearly more in-depth research is needed in the area of technology in education and more specifically, technology's impact on mathematics. Studies by Eley (2008) noted that some students' academic performance did increase but not significantly. Typically, students mimic their teachers/instructors and engage in exercises without learning and developing vital skills and understanding of the concept(s) (Chazan, 1993). These results are similar to findings discovered by Vygotsky (1978), in which he states, "it's decisively important that speech not only facilitates the child's effective manipulation of objects but also controls the child's own behavior" (p.26).

Theoretical Framework

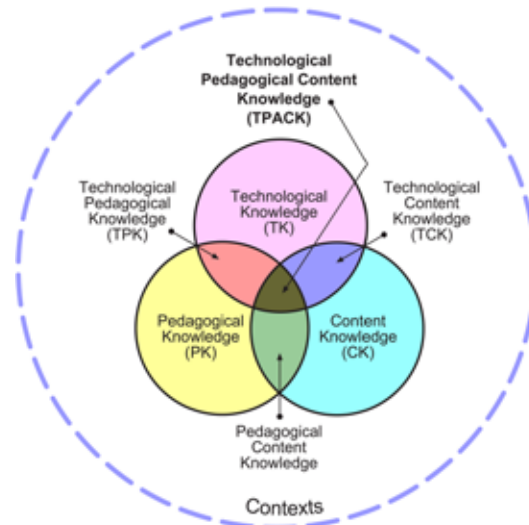
Technological Pedagogical Content Knowledge (TPACK)

The notion of what teachers need to know to be able to teach is not a new idea. Shulman (1986) brought forth the concepts of what a teacher needs to know, which is known as pedagogical content knowledge (PCK). Building on this concept of PCK several authors utilized this principle and discovered a more advanced framework for understanding how technology should be used in teaching. More specifically the focus on the intersection of the three concepts.

This framework focuses on technology, pedagogy and content knowledge, also known as TPACK (Koehler & Mishra, 2005; Mishra & Koehler, 2008; Niess, 2005,

2006; AACTE Committee on Innovation and Technology, 2008). TPACK refers to the intersection of content, pedagogy and technology (Koehler & Mishra, 2005; Mishra & Koehler, 2008) (see Figure 1).

Figure 1



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Niess (2005) described four different aspects that comprise teachers' TPACK (as cited in Lee & Hollebrands, 2008):

1. An overarching conception of what it means to teach a particular subject integrating technology in the learning process;
2. Knowledge of instructional strategies and representations for teaching particular topics with technology;
3. Knowledge of students' understandings, thinking, and learning with technology; and
4. Knowledge of curriculum and curriculum materials that integrate technology with learning.

These four components are critical to teachers' success when utilizing technology in the classroom. Therefore, it is deemed essential to being effective while using technology to teach.

METHODOLOGY

The methodology for this study invokes the use of quantitative methods. The use of quantitative methods will measure statistical significance and student academic improvement from pre and post-test (Gall, Gall, & Borg, 2003). The study was conducted in eight (8) high school algebra classrooms. The students were allowed to work with the technology on an individual basis to accomplish classroom task(s).

Teacher & Student Training

When working with new technology a learning curve always exist. Therefore, a 2-day 1-hour each day training was provided to teachers to teach them how to use the LiveScribe SmartPen. Each teacher was provided a smartpen and the appropriate software to fully utilize the pen. Teachers were instructed on how to create pencast pdf files and how to share this information with their students on various platforms such as YouTube and Facebook.

Teachers were given an adjustment period of 2-weeks to become familiar with the technology so that they would be comfortable interacting with students. Teachers then began to record their algebra lessons. The technology allowed recording to take place at home or during planning periods so that students would have access to the files to learn the lessons at their own pace on the computer or some other technological device (i.e. iPads).

The students that participated in this study each had their own laptop computer and headphones. This was important because it allowed each student to individually access the classroom notes for the lesson that was to be taught that day. Each student was able to access the notes and work at their own pace, using the pencast videos that were created by the teacher. The process was repeated each day until the end of the study.

Data Collection & Analysis

The data collection was conducted by survey. The surveys were given to the students via an Internet link that directed the students to the online survey which asked several questions. The questions in the survey covered basic descriptive statistics and recorded students' response on a likert scale. The pre-survey was completed with n =187 Algebra I students. Further more after the completion of the 4 week treatment a follow-up post-survey was completed by n=58 students.

The analysis of the survey data was conducted using the paired t-test. This test was used to determine if a statistical difference exist among the means of each survey question. This study reports on the significant findings and discusses several questions. The paired t-test was the most appropriate quantitative test since the researchers were able to identify each students' survey via identification numbers so that they could be paired accordingly.

Results

Descriptive Statistics

The population of 187 students was narrowed down to 58 students because of missing data entries of post-surveys. We utilized $p < .05$ to determine statistical significance for our paired test. The population of students that participated in this study was diverse. The demographic analysis of the students in the study was 63.8% Black, 22.4% Bi-racial, 5.2% White, 5.2% Hispanic, 3.4% Indian (see Table 1). The socioeconomic profile was as follow 79.3% free/reduced lunch, 89.7%, 9th grade students, 93.1% have computers in their home 93.1% and 62.10% like math (see Table 2).

Table 1

Race	Frequency	Percent
black	37	63.8
white	3	5.2
hispanic	3	5.2
bi-racial	13	22.4
indian	2	3.4

Table 2

Student Profiles	%
Free/Reduced Lunch	79.3
9th grade students	89.7
Computer in your home	93.10%
Students like math	62.10%

Results from the survey revealed a significant difference in student note taking after watching Smartpen videos with a p-value of .002. Additionally, students needed less time to cover a concept after using the smartpen, which was highly significant with a p-value of .00001 (see Table 3).

Table 3 Significant Results of Survey

N = 58	df	μ	SD	paired t-test	p-value
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Note taking increases after watching Smartpen videos?	57	0.155	0.365	3.236	0.002
How many times do you need to cover a concept to understand it after using the Smartpen?	57	-0.603	1.107	-4.151	0.00001

DISCUSSION

The purpose of this study was to determine if Smartpens help students learn mathematics better than using traditional methods. The answer to this question is yes and no. Yes, it does help students to learn better however; there was not enough evidence to directly suggest that a significant increase in test scores occurred. However, what the researchers discovered has a lot of promise for classroom applications and student engagement.

Using technology like the Smartpens with pencast allows the teacher to be everything to everyone. Each student is able to work at their own pace since they control the pencast and are able to go back over concepts an unlimited amount of times. More importantly it gives the student anonymity in the classroom. Students don't feel embarrassed if they need to review concepts that they did not understand. In contrast, students that are ready to move on to the next concept are able to move along at a faster pace that is conducive to their learning, possibly giving the advance students the opportunity to cover more concepts during the same class period. This is promising because it promotes equity in mathematical learning among students because each student is receiving the support they need on the level they need. The teacher then transforms from instructor of information in the classroom to facilitator of learning.

Advantages to the population of students in this study include the following: (1) the teacher was able to come and provide more individual support where it was needed; and (2) teachers were not subject to spending most of the class time teaching the concepts but rather time was dedicated to help students work through problems they did not understand. As a result students were able to get the personalized instruction that many of them desire.

Statistical results from the survey suggest that the more students become engaged in the class material, the more notes they take. Note taking is important in mathematics because students are able to review and reflect on concepts and steps to problems. Students with incomplete or few notes do not have the ability to review material if they run into problems doing homework or while studying for test. Students indicated in the survey that they enjoyed working with the Smartpens, which may suggest that students take more notes because using the technology motivates them.

Students indicated at a significant level that they review concepts fewer times as a result of using the technology. The data suggest that students are more focused because they are working at a pace that is comfortable for them. Therefore, they absorb the information at a faster pace thus, needing less time to review the same concepts. Findings from this study suggest students who are allowed to work at their own pace under teacher supervision are motivated by the technology and learn more quickly.

IMPLICATIONS FOR PRACTICE

Smartpen technology can be applied to any field of study that requires note taking. This can transform classrooms by providing teachers an easy alternative to flipping the classroom with minimum training. Furthermore, the Smartpen allows teachers to create pdf files that can be given to students during class, which supports equity. Equity is supported because students do not have to have Internet access, only the computer that was provided by the school. This eliminates socioeconomic factors from being a barrier to the students.

Many of the current technologies that exist to support students in providing individualized instruction are expensive and need extensive support/repair to be maintained in working order. Smartpens using pencast are very inexpensive and can be recorded anywhere, anytime and anyplace. Therefore, they can be an excellent alternative to financially challenged districts that need an effective technological tool.

Lastly, Smartpen technology using pencast can empower teachers that are absent from the classroom. Pencast lessons are pre-recorded and students work at their own pace, therefore when a substitute teacher is needed, they only have to give the students the work pdf files that their teacher has already recorded. Students do not miss instructional time and the instruction is consistent. Furthermore, when a student misses class, they only need to be given the pdf files and they are able to be current with class instruction.

Smartpen technology has a bright future and we have only scratched the surface of the possibilities that exist. This technology is only limited by the creativity of the teacher. More importantly it will allow the students to finish the race at their own pace.

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