# TRANSFORMING TEACHER TECHNOLOGY USE: RESULTS FROM SUMMER INSTITUTE TRAINING

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## Introduction

AP* Institutes, which are approved by the College Board, are led by consultants who teach in the secondary classroom during the school year. These summer institutes provide at least 30 hours of professional development for teachers. Melissa Burkhead is one of those instructors, and has led AP Calculus and Pre-AP Mathematics Summer Institutes at a number of universities in the Southwest. For the past 9 years, she has led a Pre-AP Mathematics Summer Institute at Texas A&M University, where Dr. Sandra Nite is the Director. This paper is based on those experiences and the results of responses to a survey of past participants from 2006-2015.

There are numerous factors that affect technology use in the mathematics classroom. A very significant factor is the level of teacher comfort. When a teacher enters the classroom feeling confident with the technology platform and ready to use it, this confidence allows the teacher to work seamless with the technology in the classroom. On the other hand, when teachers do not have experience with the technology, they are less likely to use it. A two-minute glitch seems like a lifetime when experience in front of a class full of students. Teachers may already be hesitant to use the technology because of the time they perceive they are losing for instruction, and technology problems exacerbate the problem.

Teacher beliefs also impact technology use in the classroom. Many teachers want to teach mathematics as they were taught mathematics. Students can often text a lot quicker than teacher, but teachers can perform other tasks (e.g., hand-writing information) more quickly than students. Teachers take into consideration how students acquire their technology knowledge as well as their own beliefs about teaching. Focusing on conceptual understanding before allowing technology to take over procedural tasks is a consideration as well. Student motivation plays a role. In the opening session of the conference, attendees were reminded of the issues of hunger and fatigue sometimes experienced by students who are disadvantaged or who had been working all night at a job after school. It can be difficulty to interest students in inductive reasoning with a computer algebra system

(CAS) calculator or to delve into the Mean Value Theorem. However, when students are motivated, they really key into technology use in the classroom.

In many schools, lack of availability is an issue. During summer institutes, teachers often share with others in the group the types of technology access they have in their classrooms. At Texas A&M University, there are many teachers who live in rural areas. But a few come from the Houston area, making quite a diverse group of people. One set of teachers might report, "I'm still trying to get an LCD projector in my classroom. And then the person beside her or him says, "Well, I've got a 3D printer; I've got an interactive whiteboard that projects to two walls in which my students can sit in groups so that I don't look like a 'sage on the stage,' and I really can develop problem solving." It is discouraging to the teacher who is still using the overhead projector. Finally, there is the lack of support and a plan for continuity. Software is purchased, and certain tablets are chosen, but often the person who makes those decisions is gone in a year or two. Schools have tablets in closets or have access to interactive geometry software, but they have not been trained in it. So training is another factor that determines how technology can be used in the mathematics classroom.

**Program Description**

During the 30-hour institutes, teachers experienced three categories of technologies: graphing calculators, dynamic geometry software, and general tools. Graphing calculators were provided through the Texas Instruments loan program. Advanced placement calculus teachers used the TI-89 titanium. The instructor demonstrated the algebra and calculus features of the machines and executed discovery-based activities that practicing teachers could take back and use in their own classrooms. An example of the rich opportunities for students to discover mathematics involved teaching the chain rule of differential calculus inductively. First, the instructor asked participants to identify patterns that emerge from differentiation. With CAS features, she charged participants to differentiate $f(x) = \sin x$, $g(x) = \sin 2x$, $h(x) = \sin 3x$, $l(x) = \sin 3x^2$. They would look at that output. From identification of patterns, the instructor would then lead the class through a formal development of the chain rule. In addition to using graphing calculators to discover mathematics, instructors designed lessons that required participants to use graphing calculators to graph a function within an arbitrary window, to solve an equation numerically, to find a derivative at a point, and to find a definite integral. Those are the four most important skills AP Calculus need to teach students so that they can use them on the exam. Therefore, that was a pretty significant focus of the week-long institute.

There were also Pre-AP Mathematics Institutes with teachers that taught Algebra 1 through Precalculus in one class. Those groups chose to use the TI-Nspire CAS. During the week, practicing teachers in the Pre-AP Institutes had more experiences with graphing calculator. They used the list app and the data and stats app to develop linear, quadratic and logistic regressions to make mathematical

generalizations. They graphed transformations of functions extensively and prosed problems that involved piece-wise functions in real life situations. Practicing teachers were apprehensive about using CAS with their students. But instructors demonstrated how CAS could be employed to allow students to demonstrate mathematical thinking instead of merely using CAS as a branding box.

With CAS features, the instructors asked teachers to solve the equation $ax^2 + bx + c = 0$ for $x$. The graphing calculator responded $x = \frac{\sqrt{b^2 - 4ac} - b}{2a}$ or $x = -\left(\frac{\sqrt{b^2 - 4ac} - b}{21}\right)$. This output opened the door for thoughtful discussion in the mathematics classroom for equivalent representations. Most all of the teachers were wanting the calculator to spit out $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$, and this gave teachers an opportunity to discuss multiple representations. CAS also allowed teaches and students to identify patterns quickly.

The TI-Nspire CAS possesses dynamic geometry applications that were explored extensively. An example would be encouraging practicing teachers to construct a parabola based on the following definition: the set of all points equidistant from a point and a line. Then they were tasked with fitting their geometrically constructed parabola to the graph of the parent function $y = x^2$. Practicing teachers were able to move from the geometric construction to $y = x^2$. They were continually asked to design instruction with technology that explored mathematics graphically, numerically, analytically, and verbally. In the Pre-AP Institutes, the practicing teachers also spent two afternoons of the week in the computer lab. There they explored mathematics activities with the Geometer's Sketchpad® (GS), found websites to enhance their mathematics teaching, watched webinars, and accessed electronic files using web storage. On GS, they learned to use the construction, graphing, and transformation features. Some practicing teachers never had time in the school year to access a webinar. Some never accessed a file through Dropbox**. Often teachers come to me after a day at the institute to obtain help to access Dropbox for the institute materials. They have never had the time to explore and learn how to use some of the common electronic tools. We have to think of small steps and progress from there. At the end of each lab time, the participants processed their lab time by discussing what they learned with the group. This activity allowed them to work more in the presentation world as they presented the knowledge they gained.

**Methodology**

Teachers who attended summer training at Texas A&M University for Pre-AP Mathematics and AP Calculus from 2006-2015 (n = 337) were asked to participate in a survey about their technology use before and in years after the institutes and

in what ways their use had changed. The technology use survey addressed use by teacher and by their students. The survey results were analyzed for technology use patterns. Free responses and comments were analyzed for emergent themes.

**Results**

Only 28 teachers completed the survey, and some of those attended more than one institute. The breakdown follows:

- 4 AP Calculus BC
- 19 AP Calculus AB
- 6 Pre-AP High School
- 2 Pre-AP Middle School
- 5 Other (Statistics, Computer Science, Physics)

The response rate was likely very low because contact information from 10 years ago was likely not current. Teacher mobility can be very high in Texas, so it is likely that many teachers did not receive the survey. The teachers who completed the survey were primarily AP Calculus and Pre-AP high school mathematics teachers. The following patterns emerged:

- The percentage of teachers in a group who increased in a particular technology use reached as high as 50%.
- High school teachers increased technology use more than middle schools teachers.
- The most common increase in technology use across groups of teachers was:
  - Lists and spreadsheets
  - Graphing piecewise functions
  - Parametric equations
  - Presentations (e.g., Power Point, Prezi)
- Middle school teachers had the fewest types of technology increases in use
- AP Calculus AB teachers reported strong use of technology for linear regression and graphing piece-wise functions

Middle school teachers had the fewest types of technology increases in use. This probably comes because, in Texas, up until 2015, middle school students were not allowed to use graphing calculators on their state exams. If graphing calculator uses are not on the state exams, teachers do not usually bring them into the classroom. I remember one time I was having dinner with a group that included the chief reader for the AP Calculus exam. I was all excited, and I said, “What type of graphing calculators do you use with your students?” And he, in a very wise, sage-like way said, “Melissa, we use 89’s. But it really doesn’t matter. When we brought graphing calculators to the AP Calculus exam in 97, 98, it wasn't so that students could graph a function with an arbitrary viewing window or find the derivative at a point. It was so that teachers would use graphing calculators in the classroom. If it’s not going to be tested, teachers aren’t going to use it.” That’s something that I just continually think of, and I speculate on why middle school teachers did not

have that technology use increase. And then AP Calculus AB teachers reported a strong use of technology for linear regression, and graphing piece-wise functions with the students. Those were some of the changes that they were seeing.

**Philosophies about Technology Use**

There were several philosophies about technology use in the classroom. One philosophy expressed was, “Student must learn on paper first.” In rural areas teachers tend to be a little hesitant to use technology. Another philosophy expressed was that technology “enhances learning through discovery and exploration.” A third philosophy was, “It’s a tool, not a replacement for that fine, fine mathematics thinking.”

**Common Barriers to Technology Use**

Teachers were asked about barriers they experienced in regard to technology use in the classroom. The most common barriers teachers identified were lack of access, lack of training, and lack of time to learn and to implement. A lot of teachers think, “I am prepared to teach mathematics. I should be prepared at the same level in the technology world.” However, technology changes so much that we have to be willing to learn from the students.

**Conclusions and Implications for Teacher Professional Development**

Results of the survey revealed several interesting perceptions about technology use in the classroom. One is that teachers value technology. They believe students benefit from using technology to discover mathematics. They realize that they need additional training in order to facilitate student learning and use of technology. However time is a challenge because teachers have many demands on the job, and keeping up with cutting edge technology that changes almost daily is very difficult. They have a strong commitment to rise to the challenge for the sake of their students. The comments were sincere and indicated that when teachers have better access to technology and technology support, they will help the students benefit immensely.

The High School teachers increased technology use more. Possibly that is the result of more time in a lab. Additionally, their course lent itself to discovering mathematics. The AP Calculus institutes teachers tended to have a greater focus on plugging through a curriculum. The teachers in the Pre-AP courses taught the range of courses from Algebra I through precalculus; hence, their explorations were more open-ended. By increasing use with lists and spreadsheets, teachers were able to facilitate student exploration of mathematics numerically and tabularly. Graphs of piecewise functions and parametric equations were used to model physical phenomena and real world problems. These applications were used to engage students in mathematical topics.

There are several recommendations for teaching professional development, based on the results of the survey. We believe that modeling a variety of technology use in future institutes and in all teacher professional development is beneficial to teachers. Technology is constantly changing, and teachers need opportunities to keep abreast of educational technologies that can engage students in the learning process and deepen their conceptual understanding of mathematics topics. We expect to set aside at least 40% of the instructional time to learn about and experience effective technologies. We also recommend some type of structure that allows teachers to communicate their needs in regard to experiencing effective technology for their classrooms. They do not always have opportunities to request the training they need in a venue that can meet those needs. Giving them opportunities to communicate their needs throughout the week allows instructors to tailor the professional development to more closely align with teacher needs. There is every reason to believe that the rapidly changing technology availability will continue to be a challenge for teachers to learn new technologies and address student interest by integrating cutting edge technology into the mathematics content. Teacher professional development providers should keep this in mind as they design PD opportunities for teachers.