BYRAM HILLS CENTRAL SCHOOL DISTRICT
ARMONK, NEW YORK

GROWTH PLAN END-OF-YEAR REPORT

Title: Evaluating the Impact of the TI-Nspire for Differentiation in the Math Classroom

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School**:** Byram Hills, Grades 9-12

SUMMARY OF ACTION RESEARCH PROJECT

Context

I currently teach a variety of math courses at the high school. I decided for purposes of this research to focus on my geometry classes. The first class was an on-level Regents class for sophomores and the other two classes consisted of freshmen in the accelerated/advanced program. As a department, we hope our geometry classes will understand how to make and test conjectures, resulting in a complex system built from basic definitions and postulates. The availability of Smartboards and TI-Nspire graphing calculators allows us to integrate technology on a regular basis.

While introducing the calculators into our curriculum last year, it became apparent that the teachers would need more time and instruction learning the full capabilities of the new technology as well as how to develop meaningful lessons that utilized its power. I also began to question if the calculator could become an additional resource for students who were struggling with the material.

Action Plan

My district has been very supportive of using technology in the classroom. This is a wonderful goal, but for technology to be successful it needs to support and enhance meaningful lessons. As I researched various sites and educators, it seemed that technology was definitely moving into classrooms every day and needed to be embraced. The National Council of Teachers of Mathematics (NCTM) has stated that "*technology is essential to the teaching and learning of mathematics: it allows students to make and test conjectures, work at higher levels of abstraction, helps students of varying abilities to learn material in a more interactive and meaningful way, develops problem-solving skills, reinforces collaborative learning, and helps students become more fluent in the technological skills needed for the 21st century.*"

I also spent many hours reading about differentiated instruction, particularly works by Cindy Strickland. Although I had planned on looking at differentiation for students of varying academic backgrounds, it also piqued my interest in looking at differentiating for interest and learning style. The concept of differentiation relies on providing each and every student with the tools needed to find success. It is with these ideas in mind, that I formulated my research questions.

1. Can the TI-Nspire graphing calculator be used in the geometry classroom as a tool for differentiation?

2. What can we learn about students' understanding of mathematics from the use of technology-inspired lessons?

Although most of the research would take place in my own geometry classes, I did share my ideas with other geometry teachers in my department. This proved an invaluable resource as my colleagues assisted in my lessons, incorporated some of the lessons into their own classrooms, and shared with me their insights and observations. After researching activities on the TI website, as well as developing my own, I would try those activities with my students. I would then gather written feedback from the students about the calculator in general and the activity in particular. I quickly realized that as I read my students' responses, I sometimes wished for certain points to be clarified or more elaborative. This encouraged me to reach out to several students for interviews. At first these lasted about five minutes apiece, but as my research progressed, some of the students would spend 15-20 minutes discussing the calculator and/or activity with me.

I also kept a journal in which I noted my personal observations (particularly related to my students' understanding of the material), comments overheard in the classroom, and feedback given to me by my colleagues. During this time, my department was visited several times by Vince Doty, a representative from TI, who shared some of his lesson and activities. I used this as an opportunity to share with him some of my observations as well as those of my students. I loved his comment that current students are "digital natives rather than digital immigrants." It helped my colleagues and I realize that our own comfort or discomfort with the technology could influence how our students connected with an activity. My discussions with Vince offered me additional support and ideas.

Results

I learned several things about my practice and how my students learn. I have outlined them below. In addition, I have included some of the feedback received from my students and colleagues. The students are usually referring to one of four major activities we did: (1) mini-golf (graphing linear equations), (2) triangle congruence, (3) properties of parallelograms, or (4) concurrency in triangles. I reference the activity after each quote.

1. For the most part, students enjoy technology. They were *more willing to stay on task* and *work through challenging material* when technology is involved. In addition, they often *continued or expanded the activity outside the classroom*.

> "I didn't know why mine wasn't working in class. I tried again at home and realized I needed to find the perpendicular first." (JY, activity 4)
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> "I like it [the TI-Nspire] because I can write my own programs and there is a lot of capability. I think some of the activities were boring, but my favorite was inscribed and circumscribed circles. I worked through that one again with some friends not in our class." (AJ, activity 4)
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> "I am glad I got it [the calculator] because it helps me remember, especially the parallelogram rules. We kept getting stuck on the diagonals bisecting the angles in the rhombus, but then I remembered that one on the test because my group tried it like 10 times." (EF, activity 3)

"I want to come at lunch and try them again on my own. Is that OK?" (IN, activity 3)

"Wow! That is so cool. Can I try it again?" (JB, activity 4)

2. In many circumstances, there was clear evidence that *students were making connections* and *attempting to understand the concept of proof*.

"Can the points of concurrency ever be the same point?" (DZ, activity 4)

When I suggested she try this at home and report back, 14 students did! They were all willing to share their findings.

"I just started drawing and measuring things because I could. CJ and I tried testing things like linear pairs and vertical angles, and they worked. Can we make up our *own* theorems if they work?" (AS, activity 2)

"Students are asking if they can bring the constant to the other side rather than distribute and combine. Is this OK? We can use this to relate to(h,k) form and transformations later." (teacher, activity 1)

"You must be wrong. The flag is higher so the slope can't be negative. Let's find the mistake." (overheard in group during activity 1)

"Last night I thought that the diagonals of a parallelogram were congruent. AJ said no because he found a counterexample and then he sent it to me." (EF, activity 3)

"I really thought AAA would work. The perimeters had the same ratio as the sides. Does that always work? Do we prove that?" (HR, activity 2)

3. Lessons *need* to be differentiated. Although some students did very well with the calculator, others expressed frustration with some activities and actually preferred the former *hands-on* model.

"I can't do SSS." (Overheard *numerous* times during activity 2.)

This led me to doing SSS with straws and paper models later in the week. Students told me they preferred this. However, many liked the calculator for the other situations presented in activity 2.

When working with activity 3, the majority of students were getting correct measures when working with segment length on the calculator, but struggled with angle measure. After discussing this with my colleagues, we generated paper models for the angle rules and most students found success.

When we realized that students were having difficulty understanding which properties of parallelograms *defined* them, a colleague developed an activity of her own. Although I had already addressed this topic in class, I asked my students if they wanted me to send them a copy to explore on their own. Almost everyone said yes. In the days after, students would approach me outside the classroom to share with me their findings.

Implications

My research showed me that the calculator can be used to differentiate instruction for students of varying abilities, interests, and learning styles. To do this successfully, time needs to be built in for educators to become familiar with the calculator and the needs of their own students. The students' feedback gave me great insight into which activities were successful, those that needed to be modified, and those that needed to be abolished.

What surprised me most was how much it altered the way my classes thought about geometry. I always tell my classes about making and testing conjectures, however, students saw this first-hand and often *discovered* theorems before they were presented in class. As an educator this was exciting! I also saw struggling students *make meaning* out of complex concepts. In addition, student retention seemed to be increased.

What hindered the success of some of my students was the fact that they didn't own their own calculator. This limited their ability to work on activities to classroom time. These students often progressed through activities slower because of their need to *familiarize* themselves with the technology again. The activities and the excitement of their peers encouraged some students to purchase their own.

As we move forward, I hope to:

- Develop more activities, particularly in the area of circle theorems and transformations. I have already started looking at TI programs in this area, and my colleagues want to explore these this summer.
- Extend this into the Algebra 2 & Trigonometry classes I will be teaching next year. I would like to continue the idea of using technology to differentiate lessons.

Most importantly, I want to explore how the calculator may help students connect big mathematical ideas and have a deeper understanding of how various topics are related. I continue to look forward to sharing and exploring with my colleagues as well as witnessing the excitement of my students.