Teachers Learn How To Effectively Integrate Mobile Technology by Teaching Students using Math Snacks Animations and Games

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ABSTRACT

The time for teachers to use mobile devices is now. However, in order to ensure that yet another technological transition in the classroom is as effective as possible there is an undeniable need for effective professional development. The models we propose in this chapter offer teachers experiences that require curriculum design and delivery, experience with mobile hardware and software, and opportunities to consider the pedagogical implications of integration for effective teaching and learning. The Math Snacks Summer Camp Model and the Math Snacks 3-Day Gradual Release Model offer experiences where *teachers and students work together* to learn challenging mathematics concepts using mobile devices, laptop computers and hands-on activities. A description of these models, including benefits and limitations is discussed. An adaptation of each model for pre-service teachers and higher education faculty is also included.

INTRODUCTION

According to the 2012 Horizon Report on the future direction of technology use, we are in the midst of the time frame where tablets and smartphones are becoming standard learning tools in many classrooms and adopting mobile devices in the classroom is becoming a must (Johnson, Adams, & Cummins, 2012). The availability, cost efficiency, and capabilities of these devices make their usefulness in and out of the classroom indisputable. The Horizon report goes on to say, "training in the supporting skills and techniques (for using these devices) is rare in teacher education," and digital literacy among practicing teachers is the exception and not the rule, highlighting the importance of effective professional development (Johnson, Adams, & Cummins, 2012). Other studies have also shown that the effective use of technology for student learning in the classroom is directly tied to the pre-service or professional development teachers receive when they are introduced to the technology as a teaching tool (Mouza, 2008; Zucker, 2009). Rubin (2000) stated that "following closely on the heels of curriculum integration as a necessary condition for technology implementation is professional development" (p. 15). Thus, it is imperative for practicing teachers, pre-service teachers and college faculty to understand how these tools can be used appropriately to enhance student learning at all levels.

Ironically, teachers, like the rest of the population, are increasingly using technology, including mobile devices, for their own personal use. However, most are not considering how these same tools can be used in the classroom. This may be due to the fact that much of traditional teaching, (stand and deliver and sit and listen) involves getting all of the kids in a classroom to do the same thing at the same time. When teachers who are used to teaching this way consider using technology, they may want all of the students on the same program at the

same time progressing at a similar pace. According to Devlin (2011), this limits the effectiveness of the technology for student learning. Thus, before any technology, including mobile technologies, can be effectively utilized to enhance learning opportunities for students, the design and management of the learning environment must be re-conceptualized (Norton and Wiburg, 2007). Once a teacher understands how students can engage in project-based learning involving team and individual problem solving, the teacher has a way to integrate technology even if there isn't a computer or tablet for every student. So changing teachers' beliefs from traditional sit and deliver methods to instruction that encourages multiple approaches to projects using technology in different ways may be the necessary condition for changing their practice to effectively integrate technology in a way that encourages student learning. Experience using mobile technologies with groups of students in different ways is something the teachers experience in the Math Snacks professional development experiences. This chapter will provide a description of two professional development models that have been used to successfully demonstrate the appropriate use of tablets and laptops with elementary and middle school teachers along with guidelines for how these models can be adapted for pre-service teachers and college faculty. Many professional development models used for technology integration consist of teachers attending a workshop with other teachers to learn the mechanics of how to use a specific application or piece of technology. This may be done in the summer, after school, or as a pullout program where teachers convene at a professional development center, attend a conference, enroll in a class, or convene online in a webinar or online course. Teachers are encouraged to use the technology when they return to their classroom, but often there is little transfer from the training to classroom practice. Additionally, if teachers are serving only as students in these professional development models, they may or may not understand the

pedagogical implications of using these new devices in the classroom. The Math Snacks team believes that team teaching in a classroom-like setting with real students offers an ideal professional development experience for teachers as they learn how to use new technology to teach specific content. The assumption is that if teachers use the technology with actual students in an informal setting, when they try to use the same tools in their regular classroom it will not be as intimidating and the transfer of knowledge from the training to the classroom will be more successful and longer lasting.

The models we are proposing can be compared to lesson study, a professional development model commonly used in Japan, which has proven to be an effective model when the goal is to change teacher practice (Ceppi-Bussmann, 2006). In Lesson Study, a team of 3-5 teachers develops a lesson that focuses on reaching a specific learning goal or big idea. The team creates a very detailed lesson plan, anticipates student questions and discussion topics, decides on questions and activities, and focuses on student thinking and best practices. After the planning process is complete, one teacher volunteers to teach the lesson with his/her class and other teachers on the team observe student learning and lesson implementation live while the lesson is simultaneously recorded. After this initial lesson, the teachers meet for a debriefing session where they watch the videotaped lesson, discuss their observations and refine the lesson. After this process, a second teacher teaches the same lesson implementing any changes made by the team and the lesson is observed and recorded again. The final debrief takes place after the second 'teach' and a report is written about the lesson and the process. Although this is an excellent process and has been found to be effective in improving teacher's comfort level and implementation of technology enhanced lessons, it is also time consuming, costly and difficult to maintain without systemic support (Wiburg and Brown, 2007). The key components we are

using from the lesson study model include the teacher collaboration, the pre-planning of lessons, teachers working with students, teachers observing lessons being taught, and the debriefing process, however we have eliminated the final report and some of the formality of the lesson study process.

MATH SNACKS BACKGROUND

Math Snacks is a five year NSF grant (0918794) funded for the development of animations and games to enhance student understanding of specific middle school mathematics concepts like ratio, proportion, scale factor, number line, coordinate plane, place value and number sense. By 2015 all of the Math Snacks animations, games and resources will be available online in English and Spanish, and most of the products will be available on the iPad and iPod free of charge at http://mathsnacks.com. A Math Snacks Animation is a short animated video that can be viewed anytime, anywhere on multiple devices. The intent of the animation is to provide the viewer with an appropriate concept image of a mathematics topic through engaging media. For example, Scale Ella is an animation that provides a concept image of scale factor by using a villain who makes things bigger and smaller and a hero who tries to remedy each situation. A comic book transcript and a learner guide that offers additional practice for students accompany each animation. Additionally, a videotaped model lesson and teacher guide that provides teachers with discussion questions, bonus activities and answers to the learner guide are also available for teachers or parents. A Math Snacks video game is a single-player, multi-level game that offers players an interactive learning experience with immediate feedback and incentives to learn and improve their math skills. Each game offers a unique experience and teaches a different concept. For example, Pearl Diver focuses on placing numbers on a number line including fractions, decimals and negative numbers. It is challenging and fun and in order to

progress in the game, players have to become more proficient in the mathematics. Each game also has support materials for teachers to use as they integrate the games into a classroom setting. From the beginning of the grant, the Math Snacks education team has engaged in various outreach projects initially intended as field tests in order to improve the animations, games and teacher support materials. However, these outreach ventures led to the development of two models of professional development where **teachers work with each other and with their students in order to develop mathematics content and pedagogy while simultaneously learning how to use mobile technologies as effective tools to increase student learning.** Model A is the ***Math Snacks Summer Camp,*** developed over two years with over 30 teachers. Model B is the ***Math Snacks 3-Day Gradual Release,*** developed during the 2011-2012 school year as a follow up to the 2011 summer camp experience.

MODEL A: MATH SNACK SUMMER CAMP

The summer is an ideal time for teachers to receive professional development. The Math Snacks Summer Camp offers an alternative to the traditional workshops, courses or conferences because the teachers are learning how to use mobile technologies while they are teaching students. In this model, two teachers work together with 12-15 students for one week and they have the opportunity to experiment with the technology while teaching the content. Many of the teachers who were involved in this model reported feeling free to try new things in this setting, but more importantly they reported that they were planning on using the same tools in their regular classrooms during the year. Another added benefit of the summer camp is that it allows a school to offer children in the community an enriching summer experience with technology that will also benefit them academically.

In District One, the Math Snacks Camp took place over a one week period and students and teachers met from 8:00-12:00 for five consecutive days. Class time was from approximately 8:15-11:30 and the school district provided the students with breakfast and lunch during the program. In District Two, the camp took place over a 4-day period where students and teachers met Monday-Thursday from 9:00-2:00. This district provided transportation, breakfast and lunch for the students. In both cases, the actual classroom time was approximately 15 hours and the teachers had access to iPads, laptops, cameras, video cameras and materials and supplies for hands-on activities.

In order to find teachers interested in participating in the summer Math Snacks camp, we contacted local middle school and elementary school principals who put us in contact with their teachers. Teachers who expressed an interest in participating in the camp were invited to an informational meeting where we shared our vision for the camp. We were looking for teachers who wanted to learn how to use computers and iPads in their classroom to teach mathematics. As an incentive, teachers were either paid a stipend or given an iPad for their participation in the summer camp. In some cases this was paid for by the grant and in other cases the funds for these incentives were offered by the school district using professional development funds.

We met with the participating teachers three times after school during the spring semester to prepare for the camp. During the first meeting the goal was to build rapport between the Math Snacks education team and the teachers. A Math Snacks specialist demonstrated a sample lesson with an animation and the teachers were the students. After the lesson, there was a discussion about the mathematics and how the technology was used as a tool to facilitate the learning process. At this time, teachers were paired up in teams of two and each teams was asked to create lesson plans to be used with a group of 10-15 middle school students during a one-week

summer camp. The lessons had to include the use of iPads and laptops daily along with a hands-on activity that would complement the content being learned with the technology. Teachers used these animations as the motivation to develop appropriate hands-on activities and projects to encourage student thinking throughout the week. At successive meetings the teachers shared their plans with each other and demonstrated their lessons informally. We discussed how each team was going to use the animations, the games and the hands-on activities to teach the mathematics and offered suggestions for questioning and activities. The Math Snacks education team and the teachers had ongoing discussions in order to refine the activities to reach the student learning objectives. In some instances the teachers were uncomfortable because they had never used mobile technologies before, but other teachers and the Math Snacks specialists were available to answer questions throughout the planning and implementation process.

As stated earlier, the Math Snacks animations address topics challenging to most students in sixth and seventh grade including ratio, number line, proportional reasoning and scale factor. In many instances, these are also topics that are difficult for the teachers. During the planning process, the teachers were able to increase their mathematical content knowledge and pedagogical content knowledge using the same technology they were going to use to teach the students. Each team of teachers used the mobile technologies in a different way and to varying degrees of success, but every teacher was able to increase their comfort level with the integration of the technology and the appropriate pedagogy associated with the effective use of the tools to teach the mathematics. Three of these teams deserve special attention for their creative use of mobile devices and hands-on activities to increase student learning.

The first team consisted of two fourth grade teachers who were relatively comfortable using mobile technology with their students prior to the camp. They had access to iPod touches

and mobile laptops in their classrooms. However, during the summer, they were interested in stretching their use of the technology. This team of teachers chose to focus on scale factor in their projects. They had students build instruments of different sizes and shapes. One group of students built drums of various sizes, another group made various horns with plastic pipe, and a third group made shakers of different sizes. The students recorded their processes using digital recording devices, downloaded their footage onto the computer, wrote and performed songs using garage band, and created an edited movie about their projects to showcase their learning.

The second team consisted of two 5th grade teachers who focused on the number line. These teachers used the Number Rights animations and the Pearl Diver game on iPods. They also chose to create a classroom number line with the students using their birthday fractions (month/day). The students created t-shirts with various representations of their fractions including numerous equivalent fractions and decimal representations. Students recorded their activities using digital cameras, created a private blog and wrote a song to perform for their parents.

The third group consisted of two 7th grade teachers who focused on scale factor and ratios. This team worked with multiple animations to solidify the relationship between scale factor and ratio. To accompany the animations and the games, the teachers divided students into small groups. Each group of students was required to select a scale factor to shrink a drum set. At the end of the week, each group of students presented a different sized scale model of a drum set and were able to take these models home.

These are just three examples of the successful use of mobile devices in conjunction with hands-on activities to learn difficult mathematics concepts. These teachers worked together to

create an effective learning experience for the students during the summer that transferred to their classroom practice the following year.

Important Elements of Model A

Daily debriefing sessions

After each day of the camp, teachers and the Math Snacks staff held a debriefing session that lasted from 45-90 minutes. The debriefing sessions started with each group describing their activities for the day. This allowed each teacher team to see what the other teachers were doing. Ideas were shared and teachers were very open about what worked and what was not effective. After each team shared their activities, the Math Snacks staff facilitated the discussion and tried to elicit feedback from teachers about how they used each of the Math Snacks products. Discussion focused on the affordances of the technology, the mathematics content, the pedagogical strategies used, and what teachers learned about their students' learning. This was a very valuable part of the day for the teachers and the Math Snacks staff.

Teachers work in teams of two

It is important for teachers to work in teams for this model to be successful**.** Teachers are more likely to try new things if they have a partner for support. If a teacher is uncomfortable with the technology or the content, they can depend on their partner for guidance. We found this to be true even if both participants were novices, but more true if one had at least some experience with technology integration. Working in teams also allowed the teachers to spread the responsibility for lesson development and delivery.

Each team works with 10-15 students

During the summer camp, the focus for the teachers should be on learning how to use the mobile technology while developing good pedagogical practices. This can be done more

effectively with a small, simulated classroom. With 10-15 students, teachers can focus on facilitating student learning and practicing good pedagogical practices like effective questioning and student centered learning. An added benefit of the small class size is the fact that two classes can share one set of mobile devices. For example, if a school has one set of 20-30 iPads or a mobile laptop lab with 20-30 computers, the smaller class size allows two teams of teachers to share one set of devices. The Math Snacks education team facilitated the sharing by having teachers sign up for times when they would need mobile devices. For example, one team would ask for iPads from 9:00-10:00 and the other group would use them from 10:30-11:30. If necessary, one set of mobile devices could theoretically be shared among 4 teams, but considerations do need to be made for charging the devices and transporting them from one classroom to another.

Student recruitment and classroom assignments

In District One, the Math Snacks Team and the participating teachers were responsible for recruiting students to attend the summer camp. Flyers were handed out to local principals and announcements were placed on the district website and in the local papers. Students were directed to the website to register online or teachers collected registrations at their school site. There was a small fee charged for the camp, but students who were unable to pay were provided with a scholarship. Fees collected were used to purchase t-shirts for the students and to cover some of the costs associated with the camp (supplies and snacks). In year one there were 27 students who attended camp, 67 students in year 2 and 87 students in year 3. In District Two, the school sites were responsible for registering students and students were not required to pay a fee. However, this model was not as successful in finding students to participate. Initially there were over 50 students who signed up during school, but only 30 students attended the camp. We

suspect this lack of participation was due to the lack of follow up with the parents and the timing of the camp, which took place in July. We would recommend that students be recruited through self-selection where parents have a vested interest and that communication is present via phone or email where possible. In both districts, the Math Snacks team divided the students by grade level while at the same time attempting to make the students groups as diverse as possible.

Teachers determine classroom lessons

During the camp, each teacher team used at least two Math Snacks animations and all of the support materials. In addition, the teachers selected from three Math Snacks games to use with their students. Teachers then used suggested bonus activities from the teacher guide or developed their own hands-on lessons to accompany the Math Snacks products. Teachers were encouraged to use the technology to facilitate a discussion that would then lead to the hands-on activity and ultimately a product for a parent showcase at the end of the week. Mobile laptops and iPads were available during both camps and in District One, a computer lab was also available. Each day the students spent one hour working on computers or iPads to play games or view animations, followed by content discussions facilitated by the teacher with the whole class or in small groups. During the remainder of the time, students were working on projects in small groups that were then presented to parents at the end of the week. This flexible structure was needed to accommodate the personal teaching styles of the teachers and the individual needs of the students.

Benefits of Model A: Math Snacks Summer Camp

1. Provides teachers time to practice integrating technology by teaching students in a classroom. Instead of teachers being the students in this model, they are practicing their skills in a setting

that mimics the regular classroom. By doing this, they are more likely to develop the confidence to use these new skills when they return to their classrooms in the fall.

2. Provides the teachers with a supportive non-threatening environment to experiment with mobile technology. The intent is to provide teachers with a successful experience during the summer that will translate into effective integration during the regular school year.
3. Facilitates collegial relationship where teachers learn from and with each other during the summer. This informal network of teachers can then be used as a support group during the subsequent school year as all of the teachers continue to implement other lessons using similar technology.
4. Provides students with a different way to access challenging mathematical topics in a non-threatening environment. The Math Snacks animations and games do not look or feel like traditional mathematics and can provide students with access to difficult mathematics concepts through technology and related activities.

Limitations of Model A: Math Snacks Summer Camp

1. Cost: This model can be costly depending on the requirements for teacher participation. In order to recruit teachers for these camps, they were given an iPad or a $400 stipend for their participation. However, when considering the cost of 'experts' who charge thousands of dollars to conduct a one-week in-service, these funds can be used to pay teacher stipends.
2. Limited teacher participation: This model can only be used if teachers are willing to spend time planning after school and are willing to work during the summer. Like any work that is required during the summer, stipends and incentives are needed to encourage teacher participation.

3. Availability of Professional Staff: It is necessary to have professional development staff available to facilitate activities during the camps and during pre and post meetings. Professional staff is also needs to observe the teaching and learning as well as facilitate the debriefing sessions. In order to implement this model, the district professional development staff or the administrator must be willing to allow teachers to learn by doing.
4. Site for the camp: It is necessary to secure a school site that has adequate technology available to accommodate the teachers and students. Often times this is not possible due to summer cleaning and repairs or the lack of technology at a school site.
5. Technology Support: It is important to have someone on site to assist with technical difficulties as needed.
6. Student Participation: This model does not work if there are no students. In order to reach 10 teachers, there must be at least 50 students. However, once a camp has been offered it is easy to recruit students. For example, each summer the Math Snacks camp has been offered, it has grown with very little advertisement. In three years, the program has expanded from 6 teachers and 27 students to 16 teachers and over 125 students.
7. Follow up: Follow up is not built directly into the model; however, this can be done through existing professional learning communities, follow up visits, and online communication. The Math Snacks staff continues to collaborate with the teachers throughout the year both formally and informally to ensure that the summer camp experience translates into the classroom practice of the teachers.

The success of the summer camp in District Two led to the development of Model B. The district coordinator of the summer camp wanted to provide students and teachers who were unable to attend the summer camp the opportunity to have a similar experience during the school

year. After much discussion with this coordinator, the team developed the model described below.

MODEL B: 3-DAY GRADUAL RELEASE MODEL

The second model for teachers and students to learn together evolved as a result of our partnership with a state-wide STEM initiative called Innovate + Educate. This group wanted to offer a series of workshops where teachers were using technology with their students to enhance the learning of math and science. The Math Snacks program emphasized the learning of mathematics using technology over a three week period where teachers and their students were transported to the Tri-Border Innovation Center one day per week for three consecutive weeks during the regular school year. The goal was to use Math Snacks animations, games and activities to help students learn specific mathematical concepts while simultaneously coaching the sixth-grade teachers on how to use mobile technologies effectively in the classroom. Due to the nature of the three-day structure, we decided to adapt a gradual release model of responsibility with the teachers (Fisher and Fry, 2008). The program started with an initial planning meeting, followed by the three instructional sessions with two interim planning meetings, and concluded with a final debriefing. During the fall and spring semester of the 2011-2012 school year, we used this model with three separate teams of teachers from three different elementary schools. During each session there were three 6th grade teachers along with all of their students (approximately 60 students in each session). All of the participating schools were elementary schools with self-contained 6th grade classes, but two schools were partially departmentalized where each teacher was a specialist in a specific subject, so there was one math teacher for all of the students in 6th grade. This project was a principal-mandated school-wide

project that involved all of the 6th grade teachers. Because this was not voluntary, it was vital to make the program exciting and non-threatening for the teachers.

Each camp day was approximately 5 hours in length with 4 hours of instruction time. On day one students were divided into two random groups, each with a Math Snacks specialist (MSS) and one or two teachers. On day 2, each teacher was assigned a random group of students from the school and the MSS taught the gaming lesson and supported the teachers as they taught the animation lesson. On day 3, the teachers taught all of the lessons working directly with their own students while the MSS observed and offered support as needed. On all three days, there were three classrooms available and the teachers had access to 30 iPads and a computer lab with 30 laptops. The day was structured so that each group of students spent at least one hour working on an animation lesson, one hour playing the Math Snacks games on iPads or on laptop computers via the web, and one to two hours spent working on other related activities or hands-on projects. The graphic below provides a visual model of the three-day structure.

Math Snacks: 3-Day Gradual Release Model

[Insert Figure 1 Here]

Figure 1

Initial Planning:

We met with the teachers during their common planning time prior to the first day of the camp to outline the objectives of the project and to cover the tools that were going to be used during Day 1. Although some of these teachers had access to smart boards, the majority of these teachers did not use any technology in their classroom and using iPads and laptops was not part

of their regular classroom practice. Similar to Model A, during this initial meeting the Math Snacks specialist showed the teachers a Math Snacks animation and a mathematics activity where they were participating as students. The teachers also had the opportunity to use an iPad, many for the first time. This was followed by an introduction to the math content that would be covered on day one and how the iPads and laptops would be used in conjunction with animations and games to enhance student learning. The focus of the meeting was on establishing rapport and solidifying a plan, not on any explicit discussion of pedagogical tools or technology integration. When they realized they would only be observing and helping on the first day, the teachers indicated they felt comfortable and willing to participate. During the interim debriefing sessions, there was more emphasis placed on the pedagogy, the content, and the technology integration.

DAY 1: Math Snacks Specialist Modeling for teachers by teaching students

On the first day, the students were divided into two groups and the Math Snacks staff from the university taught the students for the entire day. The teachers were asked to observe and to assist students as needed. The goal of the first day was for the teachers to see how to use the mobile technology as a tool for learning mathematics using the Math Snacks products. We were not only modeling the use of the technology, but also pedagogical strategies by teaching the Math Snacks lessons.

An animation lesson includes using the technology to view the animation, a hands-on activity, and the completion of a learner guide specifically created to accompany the animation. These activities are balanced with classroom discussion about concepts and vocabulary to ensure maximum student understanding of the concepts. When appropriate, students are exposed to

games on the iPad or the laptop that further supports the content of the lesson. Typically the lesson starts with students watching the animation, followed by a teacher-facilitated discussion about the mathematics content. This includes conceptual questioning to gauge what the students understand and a review of the important vocabulary. This discussion is followed by the hands-on activity associated with the mathematics content within the animation and the completion of the learner guide. This three-pronged approach utilizing technology, hands-on activities and a paper and pencil worksheet allows students to look at the content using various modalities, which hopefully translates into a deeper understanding of the content.

For example, when the class is watching the Number Rights animation, the Math Snacks specialist asks questions to examine what the students are thinking. These questions expose the students' concept image associated with the mathematics content, which can then be used to further develop their understanding (Tall, 1991). The hands-on activity for this lesson involves students creating a human number line that includes decimals, fractions and negative numbers. The activity is then followed by completing the learner guide which includes questions and activities to further stretch student understanding of the concepts. The animations and comic book transcripts can be available to the students on the iPads for reference throughout the activities and the completion of the learner guide.

The video gaming portion of the day consists of the students and teachers playing video games created by the Math Snacks teams. Since these games were still in development, the sessions served three purposes. First, students were able to learn about place value, number combinations, and the coordinate grid through game play. Second, students were able to provide feedback to the development team in order to improve the game play and the content of the

games. Finally, the Math Snacks team members used this time to demonstrate an effective model of game play for the teachers. Students were not simply placed in front of the computer to play games, the Math Snacks team, and later the teachers, had discussions about content before during and after play. These discussions included clarifications about the math content, students sharing effective strategies, and progress reports on student successes and challenges within the games.

Interim Planning 1:

Two to five days after the first session, the Math Snacks team met with the teachers to discuss technology integration, pedagogy and the mathematic content covered from Day 1. First, teachers were asked to think about how the technology facilitated the learning for the students. Second, teachers were asked to think about how the students interacted with the video games. Next, there was a discussion about the questioning techniques and the student discussion that was modeled throughout the day. Finally, the team planned for day 2. Teachers were provided with a teacher guide and a lesson plan protocol to use for planning purposes. This protocol had step-by-step instructions on how to use the animation, from stopping the animation and asking questions to setting up the corresponding activities. The teachers appreciated these guides because they provided a roadmap for the facilitation of the lesson and the technology integration. The teachers were able to observe during Day 1, ask questions during the interim meeting, and now had a guide to follow when planning Day 2. This differs from the freedom the teachers had during the summer to plan their own activities. However, this change was necessary due to the time constraints and the comfort level of the teachers involved.

DAY 2: Team-teaching by Math Snacks Specialists and teachers.

On day 2, each teacher was asked to lead the animation lesson including the accompanying activity and the learner guide. Although the teachers were nervous, the presence of the Math Snacks specialist and the lesson protocol provided them with an increased level of comfort. The Math Snacks specialists offered support to the teacher during this portion of the day and were available to assist students with both technology questions and mathematics questions. The Math Snacks specialist continued to facilitate the video game portion of the day while the teachers played the games themselves and observed the students playing the games.

Interim Planning 2:

After day two, the Math Snacks team met with the teachers at their school site during common planning in order to reflect on Day 2 and plan for Day 3. During this session teachers reflected on how they used the technology with the students. They shared with one another what worked and what still needed improvement. The planning portion of this meeting was very important because teachers were responsible for all of the lessons on Day 3, including the animations, the activities, the use of the iPads, and facilitating the video game play. Each group of teachers came up with a slightly different way to conduct the activities on the third day. Two of the school teams decided that all of the teachers would work with their own class during every portion of the third day. The other group decided that one of the teachers would facilitate the animation and learner guide, another teacher would facilitate the activity with the iPads, and the third teacher would facilitate the video game play with the laptops.

DAY 3: Teachers using Math Snacks with support from Math Snacks Specialist

On day 3, the teachers were asked to plan the entire day including the use of the mobile devices, the activities and the use of the computers. For all three groups the third day began with the teachers doing a recap of the first two days including a review of relevant mathematics vocabulary and concepts, such as ratio, number line, and scale. The teachers from the first school decided to use this day to combine the number line animation and the scale factor animation. The students created a scale model of a house and used their birthday fraction (month/day) to determine their address on the number line. Each student created a scale model of a house for his or her relatives to live. Their relatives (equivalent representations of their fraction) were placed in their house, which was then placed on a class number line. The teachers used questioning to guide the students as they created a class number line. The teachers from the second group chose to focus on proportions and measurement for the third lesson and effectively used the animation and activities with the students. The Math Snacks team observed the teachers using effective questioning and the mobile technology was used as a tool to facilitate the learning, but it did not dominate the lesson or the activity. The final group chose to focus on scale. One teacher facilitated the use of the Scale Ella animation and the learner guide, another teacher facilitated a scaling activity, and the third teacher assisted the students in the computer lab. At the end of each of these sessions, an external evaluator gave the students a post-test and they each received a certificate acknowledging their participation. The teachers and students took all completed projects and activities back to their own classrooms for display.

Final Debriefing:

The Math Snacks staff met with the teachers in each session one week after the third day to discuss the experience. All teachers had an observable shift in their comfort level with the

technology. For example, one teacher, who had never used an iPad before the camp, was engrossed in playing Pearl Diver with his students. When asked, all of the teachers said they would use the animations and games in the future. All of these teachers were looking forward to the availability of mobile technologies at their individual school sites and in their classrooms.

Important Elements of Model B:

Model Teaching:

This first day allows the teachers to see first-hand how the technology, pedagogy, and mathematics coincide. The teachers observe the Math Snacks specialists as they demonstrate how to use animations, activities and games effectively while simultaneously asking probing questions as students interact with the technology and the content individually, in small groups and in large groups. **Teachers get to see how the technology and the classroom practice directly affect students, instead of being told how the technology and the techniques might affect the students.**

Partial Release-Team Teaching

The second day the teachers are able to practice using animations and the iPad knowing that the Math Snacks specialist is available. Teachers are encouraged to use probing questions, active learning, various grouping strategies and closing discussions with the students and the Math Snacks personnel is available to assist in all of these activities. The teachers adapted the technology use and the lessons to their own style of teaching, while at the same time incorporating strategies modeled on the first day and found in the teacher guides.

Individual Teaching

The third day is where the teachers' use of the technology and the teaching strategies come together. The teachers have the opportunity to use animations, the iPads and the computers to facilitate learning. Although all of the teachers had some trepidation about this final day, most of them left with a renewed understanding of how mobile technologies can be used as a piece of an effective lesson to teach mathematics. Anderson (1997) suggests that the more modalities (visual, auditory, and kinesthetic) used in introducing a concept, the easier it is for students to learn and retrieve the concept from memory. Similar to Model A, the goal of this experience is not to make the mobile technology the primary focus of the learning, but to show how, when used properly, animations and games can be used to prompt discussion, offer practice, and serve as a spring board to other activities, thus offering students the variety needed to embed the proper mathematical concept images.

Interim Planning, Debriefing and Reflection

Like in lesson study, the preliminary, interim and final meetings serve three purposes. First of all, there is collaborative planning throughout this process. The initial meeting serves as an introduction to the content, the technology and a demonstration of the pedagogy. The interim meetings are valuable for debriefing and planning. The final meeting offers teachers the opportunity to reflect on the journey they have taken. In all three sessions, the teachers said they felt more comfortable with the technology, admitted they learned some mathematics, and said they were more likely to use other animations and games in their own classrooms because of this positive experience. A few of the teachers even saw how the content could be transferred to subjects other than mathematics. In fact, the social studies teacher said the students recognized

number lines in her classroom when they were doing timelines. Another teacher said that she had always done a scaling project in the past where students were utterly confused, but when she did it after the camp and referred to the technology and the activities, the students were able to transfer their knowledge with little difficulty. Connections between the mathematics learned through Math Snacks and other subjects reinforce applied math knowledge, which we know supports longer retention. (Cognition and Technology Group at Vanderbilt, 1997).

Benefits of Model B: 3-Day Gradual Release

1. The gradual release model is incorporated in a non-threatening way. Teachers are able to witness a model lesson, be a co-teacher in an actual lesson, and then are finally asked to deliver a on their own with support available as needed.
2. Teachers are learning with their OWN students.
3. Teachers are working together in a grade level team to enhance their mathematics teaching with mobile technology.
4. Students get to experience new ways of learning mathematics.
5. Students and teachers get an extended period of uninterrupted time to focus on specific mathematics topics and hands-on activities.
6. Teachers are not removed from their students and substitutes do not have to be paid.

Limitations of Model B: 3-Day Gradual Release

1. Teacher buy-in: It is very important for the teachers to be willing participants in this model. Although we did not experience this first hand, it is possible to have a teacher who would refuse to work in the gradual release model, especially the second and third session.

2. Transportation: Each session was conducted off-site and it was necessary to transport students to and from school. Although conducting the workshop off-site is optional, it did add an important element to the experience and is recommended if possible.
3. Cost: Some professional development models are designed to affect a large group of teachers, but this model is specifically designed for a small group of 3-4 teachers per session.
4. Technology support: The technology associated with the sessions had to be formatted for each day. Applications had to be loaded onto the iPads and the games had to be accessed on the laptops. Additionally, only some of the schools had immediate access to similar mobile technologies at their school site. Although it was anticipated that all schools would have access in the near future, they were not immediately available to the teachers.
5. Follow up: Follow up is not built directly into the model, however, the Math Snacks specialists did continue working informally with these teachers throughout the school year.

ADAPTATIONS OF MODELS FOR PRE-SERVICE TEACHERS

Model A: Summer Camp Internship:

Pre-service teachers are required to do many things in the teacher preparation program at New Mexico State University, including a technology integration course. This course could be offered in the summer with an integrated summer camp internship. Summer courses generally run 5 weeks in length and meet for approximately 8 hours per week. If the summer course schedule were adapted, these teacher candidates could intern in a summer camp teaching students math with technology, similar to Model A discussed above. If the technology course is not deemed an appropriate placement for this model, it may be possible to substitute one of the practicum experiences usually done during the regular semester for an internship in a summer camp with students. A possible schedule for this scenario is provided below.

Week 1: (8 hrs) Introduce pre-service teachers to various mobile technology tools including laptops, tablets, iPods, and smart phones and how they can be used in an education setting by having these pre-service teachers work with these tools to learn specific content related to their chosen field of study. This would provide them with some experience as 'students' using these technologies to reach an educational goal.

Week 2: (8hrs) Pre-service teachers would work in teams of two to design one week of lessons using mobile technologies as a tool to reach specific learning goals. Time in class would be spent explicitly discussing the pedagogy of how the technology can be used with students in the classroom as a tool for learning.

Week 3: (20hrs) Pre-service teachers would work in the camp setting with a group of students using the lessons they created. The professor could serve as the observer and, when possible, in-service teachers could serve as mentors. After each camp day, pre-service teachers would debrief and plan for the following day. Lessons could also be recorded and watched for further reflection.

Week 4: Based on their camp experience, the pre-service teachers would reflect on their practices, modify lesson plans and write a report about what worked, what could be improved, and how the mobile technologies were used as effective tools to improve student learning.

Follow-up: Students could utilize these lessons during a practicum experience or student teaching experience in the future.

Model B: Gradual Release Practicum

Model B can also be adapted for pre-service teachers by using the required technology integration course or a required practicum experience. The three-day gradual release model could be incorporated into the technology course or a practicum course where the students spend

one session observing an actual classroom teacher using technology effectively in the classroom. This could be followed by a debriefing session with the classroom teacher and with other pre-service teachers. A team of two pre-service teachers could then design a lesson and present it to their fellow pre-service teachers. Each lesson would be followed by a debriefing session so that lessons could be refined. Finally, the pre-service teachers would present their lesson to an actual classroom of students at a cooperating school site. A final debriefing session would take place where the pre-service teachers could reflect with the classroom teachers and the course instructor on their use of technology, pedagogy and student learning.

ADAPTATIONS FOR HIGHER EDUCATION FACULTY

Model A: Faculty Summer Camp

A similar model of a summer camp actually took place at NMSU led by one of the faculty members with expertise in technology and learning. Professors were given an iPad if they agreed to participate in a one-week technology integration camp where they learned how to use Google docs, twitter, webinars, laptops or other online and mobile devices in the classroom. The professors worked in teams to design lessons for use in their fall classes, presented them to the larger group and then met during the fall semester to further discuss the use of mobile technologies in the classroom. At the beginning of this session, the sentiments about Twitter and other networking tools on mobile devices was foreign to the faculty, but after using these tools during the summer session and again in their classroom, they were still interested in learning more. The professors from the first session returned for additional training the following summer and a new cohort of faculty started the process. Although this particular model did not have professors working directly with their students during the summer, team planning and debriefing were key elements of the summer experience. The professors used their lessons in the successive

summer session or during the fall and continued to meet and debrief about their experiences to improve their lessons and classroom practice.

Model B: Faculty Gradual Release

The gradual release model with mobile technology may be developed in the same way for faculty at the university level. Faculty professional development would be done in their own classrooms over a three-week span, with university technology mentors modeling the first week, the faculty members and technology mentors working together during the second week, and the faculty doing their own technology enhanced lesson with support from the technology mentor during the final week. This model could be used with faculty who are interested in transitioning from a traditional classroom approach to a classroom where mobile technology tools and applications become an integral part of the teaching and learning process at the undergraduate and graduate level.

FUTURE RESEARCH IMPLICATIONS IN FIELD OF MOBILE DEVICES AND PROFESSIONAL DEVELOPMENT

The Math Snacks Summer Camp and the Math Snacks Gradual Release Model provide two scenarios where teachers work directly with students as they learn to use mobile technologies to enhance student learning. Based on preliminary anecdotal evidence, these models show promise, but follow up with participating teachers will have to be done in order to confirm whether or not participation in these professional development activities leads to an increased use of mobile technologies in the regular classroom setting.

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KEY TERMS

1. **Concept Image**: The image a person associates with a given mathematical concept, including how they use that concept to apply to real world situations and other related mathematics problems.
2. **Learner Guide**: A two-page worksheet designed for a specific animation that has both open ended and practice problems used that reinforce math concepts addressed by an animation.
3. **Math Snacks Animations**: Short animated videos designed to help viewers develop the proper concept image of a particular mathematics topic.
4. **Math Snacks Specialist:** (MSS) An individual familiar with the mathematics and the pedagogical content knowledge necessary to demonstrate effective use of technology to support mathematics learning of both students and teachers.
5. **Math Snacks Video Game:** An interactive game designed to help players develop a conceptual understanding of specific mathematics content through an engaging interactive interface.
6. **Teacher Guide:** A multiple page document designed for a specific animation that provides teachers with vocabulary, discussion questions, bonus activities and answers to the learner guides.