

# Cases on Educational Technology Implementation for Facilitating Learning

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# Chapter 11

## Use of Apple iPads in K–6 Math and Science Classrooms

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### EXECUTIVE SUMMARY

*In this chapter, the authors review how iPads were used in a middle grade math classroom of a technology magnet school. The school has received two mobile iPad carts in addition to the three they have. Ms. Martin, a science teacher at this middle school, has received one of the mobile iPad carts due to her interest in technology integration. Ms. Martin is considered to be an early adopter of technology at her school, and she has been using iPads for more than a year in her sixth grade classroom. Ms. Bennett, who recently received 25 iPads, paid a visit to Ms. Martin's classroom to learn how to integrate iPads in her science classroom. This case study describes Ms. Bennett's visit to Ms. Martin's classroom on the day when the students were studying how to solve inequalities by using addition and subtraction. Ms. Bennett's goal for the visit was to identify the different ways Ms. Martin was using iPads with her students, and monitor the comfort level of her students with the iPads. She documents what she learns from the visit, and discusses it with Ms. Martin; she also meets with Mr. Pallapu, the technology facilitator at school. Ms. Martin shares some tips and techniques that she can use in her classroom, and also some benefits and challenges of using the iPad. Mr. Pallapu provides her with a list of recommended apps and instructional strategies for using iPads in the classroom.*

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## **MOBILE LEARNING**

The use of wireless, mobile, portable, and handheld devices is increasing and diversifying throughout the world (Traxler, 2009). Mobile devices such as iPods and iPads are being used as learning tools in the traditional classroom. However, many teachers are using iPads only for in-class activities by just replacing the laptop or desktop computer. Phones, computers, and media devices now fit into our pockets and can connect us instantaneously to a world of information in various locations on the go. Quinn(2000) defines mobile learning as the “intersection of mobile computing and elearning and includes accessing resources anytime from anywhere.” Today, mobile learning utilizes both handheld computers (tablets) and mobile smart phones such as an Apple iPhone or Android cellular phone. These devices are equipped with operating systems that allow the user to connect to the internet with the added functionality of mobility.

This convenience of accessing information anytime from anywhere through mobile technology gives the learner the freedom to learn at their convenience and allows them to gain knowledge in additional areas of interest that may not have been available to them (Traxler, 2009). Students today grow up with some form of technology in their hands at younger and younger ages. The use of these technologies allows teachers to “think outside the box” and give their students a more motivating learning environment. Mobile technologies engage students through the use of video and audio that goes beyond reading a textbook. The use of video and audio enables auditory, visual, and kinesthetic types of sensory perceptions-to be engaged during the learning process (Franklin & Peng, 2008). Several studies have been conducted on integrating iPads in the traditional classroom and how it benefits learning and teaching (Shepherd and Reeves, 2011; Barseghian, 2011; Jennings, Anderson, Dorset, & Mitchell, 2011).

### **Problem**

Mobile Devices are everywhere. Students are growing up with mobile devices, and a number of them own a mobile phone or a tablet. Schools have been buying iPad carts and teachers are exploring ways to integrate them in their classroom. They are still in the process of learning how to utilize the interactivity and accessibility of mobile devices to increase student learning. In this case study we see one such example, where a middle school has received mobile technology, and a teacher is trying to figure out how to utilize the iPads effectively.

## **ORGANIZATION BACKGROUND**

### **The School**

Wellington Middle School serves students in 6<sup>th</sup> through 8<sup>th</sup> grade, with a curricular focus on math, science, and technology. The school provides a high quality education program that integrates technology into the curriculum, while fostering a love of learning. Children learn technological skills that are pertinent to their success in school, career and life. In the 2011-2012 academic year, the school had 784 students and 29 teachers.

Wellington Middle is a technology magnet school, and they received magnet funding towards technology. The following technologies are available in all the classrooms at this school:

- Five Mobile iPad carts (25 ipads/cart) for selected teachers/classrooms
- Wireless access for the entire campus
- 3 Computer Labs
- SMART Board with Projector in every classroom
- Networked teacher laptops for every certified staff member

At this middle school, teachers are highly involved in the adoption of technology as a platform for learning. The mission of Wellington Middle School is to provide children an excellent education in a healthy and safe learning environment, where they are prepared with the critical skills to reach their full potential in a twenty-first century global society. Their vision is to build and sustain a productive learning community, in which all members are challenged to achieve their highest academic potential.

### **The Team**

Two teachers and a technology facilitator were involved in this project:

- **Ms. Rita Martin (Sixth grade math teacher from Wellington Middle School):** Ms. Martin has been teaching at this school for the last 10 years and considers herself an early adopter when it comes to technology. She is always willing to try new technology to make her lessons more motivating and effective.

## *Use of Apple iPads in K-6 Math and Science Classrooms*

- **Ms. Tara Bennett (Sixth grade science teacher from Wellington Middle School):** Ms. Bennett is currently in her third year of teaching. She is interested in using technology, and is always looking for technology integration learning opportunities.
- **Mr. Jason Pallapu (Technology Facilitator at Wellington Middle School):** Mr. Pallapu is an instructional technologist, and has been the facilitator at Wellington Middle school for 9 years. In his 9 years at Wellington Middle, he has seen a number of new technologies brought into the school. He always encourages the teachers to check out and use the technologies in their classrooms.

### **Purpose of Visit**

The school has received two new mobile iPad carts, in addition to the existing three. Ms. Tara Bennett, a science teacher who received 25 iPads and would like to start using them in her science classroom.

Ms. Bennett has taken her students to the computer lab every week. From her experience, she has noticed that technology in the classroom can benefit student learning in several ways, such as increasing student interest in rote tasks, attaching meaning to an ongoing lesson, allowing for individual student differences and also affecting students' attitudes toward learning. Here are a few ways Ms. Bennett has been using technology in her classroom:

- She uses technology for information retrieval via the internet. She directs her students to a variety of online labs for simulation activities.
- She uses the SMART board technology in class to present.
- She uses technology for online communication. She has a class blog that she updates frequently.
- She also uses digital cameras and data collection probes for different activities.

After hearing about the ways Ms. Rita Martin uses iPads in her classroom for over a year, Ms. Tara Bennett wants to find out the different ways she can use the iPads with her students. She has heard from the other teachers and the technology facilitator that Ms. Martin was an early adopter of iPads and that her students enjoy using them. She sets up a meeting with Ms. Martin to discuss how to effectively use the iPads in the classroom. They met for 30 minutes, where Ms. Martin excitedly explained the different activities she does in her math class. She uses Math websites and apps for practice activities to solve Math problems. Ms. Martin extended an invitation for Ms. Bennett to visit her class.

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She visited Ms. Martin's classroom to observe her using iPads with the students. On the day of visit, the students in Ms. Martin's class were studying how to solve simple one and two-step equations or inequalities.

### **Students**

Ms. Bennett wanted to know more about the students and how comfortable they were with using technology. There were 22 students in the class, among which 8 were African-American, 11 were Caucasian, 1 was Hispanic, and 2 were Multi-Racial. There were 9 male and 13 female students. Ms. Martin indicated that 20 students in her class owned some sort of mobile device, among which 5 of them owned an iPad.

### **CASE DESCRIPTION**

This case describes the 50 minute class period when Ms. Martin's students were using iPads to solve simple (one and two-step) equations or inequalities. The 22 students were all seated at their desks when Ms. Bennett entered the classroom. Once the class started, they went and got an iPad from the mobile carts. It took about 5 minutes for all of them to get settled. It took less than a minute for the students to start the iPads. They all seemed to be comfortable, swiping and turning on the iPads.

Ms. Martin took a minute to introduce the visiting teacher. She seemed very comfortable in her classroom and had control of the class. She introduced the instructional goal for the lesson to the students, which was "You will be able to solve inequalities by using addition and subtraction."

Ms. Bennett took a seat at the end of the classroom, and took a note pad and started taking notes. Her goal for the visit was to identify the different ways Ms. Martin was using iPads with her students, and monitor the comfort level of her students with the iPads.

### **Pretest**

Ms. Martin administered a 10 item multiple-choice pretest to measure existing knowledge of addition and subtraction inequalities. The average score on the pretest was 3.2 (32%). Following the pretest, students went and picked an iPad from the mobile cart and were asked to navigate to specific video tutorial websites.

Sample Pretest items are shown below.

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1. Which of the following is a solution to the inequality below?  
 $1 \geq d$ 
  - a.  $d = 1$
  - b.  $d = 2$
  - c.  $d = 3$
  - d.  $d = 4$
2. What inequality does the number line in Figure 1 show?
  - a.  $x < 2$
  - b.  $x \geq 7$
  - c.  $x < 3$
  - d.  $x \leq 2$

### Instructional Plan

The instructional plan for the class period was to demonstrate how to solve the inequality problems (20 minutes), followed by discussion (5 minutes), and ended with hands on practice problems (25 minutes), which were to be completed on the iPads.

Ms. Martin wrote down in her notes about the class structure. The class started with demonstrations which are helpful in showing how to solve math problems, then had discussions to clarify and address any questions that students had. After the demonstration and discussion, time was set aside for hands on activities using iPads to solve problems.

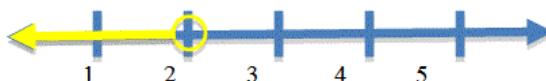
### Instructional Material

Two web sources of instructional material were used in the classroom: instructional videos with worked examples and instructional websites with practice problems and immediate feedback.

### Demonstration Using Worked Example Instructional Videos

Originally, Ms. Martin was going to allow the students to access two YouTube videos, using their iPads, from Khan Academy that provided examples of how to solve one

Figure 1. Number line



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and two-step equations or inequalities. However, the students were unable to access youtube.com videos because of parental blocks on the iPads. In a bind, Ms. Martin used a laptop to project the videos to the entire class. It took about 25 minutes to watch the two videos (Khan Academy, 2011) and each video demonstrated how to solve four inequalities.

Ms. Bennett took notes that Ms. Martin did not pre-plan the use of these websites on the iPads. She could have avoided this situation of parental blocks if she had tried out the websites on the iPads before class.

### Practice with Feedback Instructional Websites

Ms. Martin realized that the technical difficulty put her behind her allotted time and she did not have much time for discussion. After students watched the two video tutorials on how to solve and graph inequalities, she quickly addressed a couple of questions and then instructed them to go to two websites on their iPads to work on practice inequality problems (Therrien, 2011; IXL Learning, 2011).

Figure 2 is a screenshot of the IXL practice website that was used in the class.

It took approximately 20-30 minutes for both classes to finish working through the five practice problems on the first practice website and twenty practice problems on the second website. Some of the students used graphing calculators for assistance. When students would get an incorrect answer, the practice websites would indicate the correct answer. The IXL Learning practice website also tracked the points scored by the students on the right of the screen.

Ms. Bennett took notes that Ms. Martin did not keep track of the scores of the students. Students used it only for practice.

Figure 2. Screenshot of IXL practice website

The screenshot displays the IXL Learning interface. At the top, there are navigation tabs: Practice, Reports, Awards, State Standards, and Membership. A 'Create an account' link is visible in the top right. The main content area shows a practice problem: 'Practice >> Seventh grade >> Inequalities: Inequalities on number lines'. The question is 'What inequality does this number line show?'. Below the question is a number line with arrows at both ends, ranging from 4 to 10. A pink line is drawn above the number line, starting at 4 and ending at 10. The number 10 has a solid dot above it, and the line extends to the right from 10. Below the number line, the instruction reads 'Write your answer starting with x (for example, x < 3)'. There is an input field for the answer and a set of inequality symbols (>, <, ≥, ≤, =) for selection. At the bottom, there are 'Submit' and 'Submit & finish' buttons. On the right side, there is a yellow sidebar with statistics: 'Problems attempted' (0), 'Time elapsed' (00:00:25), and 'SmartScore out of 100' (0).

## Posttest

After the students finished their practice problems, the students were given a 10-item multiple-choice posttest similar to that of the pretest, but with varied questions. The average score on the posttest was 8.2 (82%).

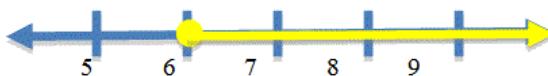
Sample posttest items are shown below.

1. Which of the following is a solution to the inequality below?  
 $x - 9 > -6$ 
  - a.  $x > 10$
  - b.  $x > 3$
  - c.  $x > 6$
  - d.  $x > 8$
2. What inequality does the number line in Figure 3 show?
  - a.  $x \geq 6$
  - b.  $x \geq 3$
  - c.  $x > 9$
  - d.  $x < 7$

## Ms. Bennett's Observation

Ms. Bennett found that students had no usability issues with the Apple iPad. Students were able to turn on and off the device, unlock the device, open the Safari application, swipe between screens, and type when it was necessary. The students enjoyed zooming into the websites to see closer and seemed to enjoy the use of the mobile device. All the video tutorial websites and the practice problems websites that Ms. Martin used were free to access, making these extremely functional websites for all students. She reflected on what she observed and wrote out a list (shown in Table 1) from her in-class observation.

Figure 3. Number line



## **Comments from Ms. Martin**

Ms. Bennett chatted with Ms. Martin at the end of the class to find out how beneficial it was using iPads in the classroom. Ms. Martin responded that students were very motivated to use the iPads and mentioned, “I had several students able to complete over 100 problems in 15 minutes. I strongly believe that if I had given them pencil and paper there is no way I could have gotten any of them to do over 100 problems.”

She also added that she is a current user and owner of an iPad, smart phone, and laptop, and was very positive about students using mobile devices as a learning tool. She believes that using mobile learning technologies benefits students because they provide an engaging and interactive learning environment as well as gathering, assimilating, and using information.

Ms. Bennett asked her for the reason why she did not test the websites on the iPad, and Ms. Martin explained that she overlooked it, as she prepared for class while at home. Ms. Bennett also asked if it would be more meaningful for her to track the students’ responses on practice activities. Ms. Martin mentioned that she would have preferred that option, but then they need to purchase accounts with the two practice websites, and that would cost money. She mentioned that the school has bought the iPads, but funds had not been set aside for buying additional apps or for buying instructional material.

Ms. Martin passed on some of the tips and techniques that she had learned over the last few months of using iPad with her students:

- Label the iPads with user ID so that you can keep track of them
- Assign a student to the user ID
- Lock the iPads to the mobile cart

*Table 1. Ms. Bennett’s in-classroom observations*

<b>Observation Item</b>
1. Students were unable to watch the Khan Academy videos on the iPad
2. Students stayed focused on the task when solving inequality practice problems
3. Students enjoyed using the mobile device to learn
4. Students did not have any problems navigating through the instructional websites
5. Students ask a few questions about the websites while using the mobile device
6. Students had no usability issues with the mobile device <ul style="list-style-type: none"><li>● Students could turn on the device.</li><li>● Students could unlock the device</li><li>● Students could swipe between screens</li></ul> Students could type when text was needed

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- Count the iPads after each class
- Use iPads for in-class projects and activities
- Use iPads for communication
- Use iPads for collecting student work
- Download apps from the app store, if you have funding for it
- Free apps come with advertisement, be sure they don't distract the students

Some benefits of using iPads in class, she noted, was that they are instant and fast. The battery life is extended, it can hold a lot of content, and students don't need much training to use it. A challenge was that she has been unable to print from it; it is limited on its interactivity with the SMART board. She also mentioned that it has been challenging to her to design collaborative activities for the students using the iPad, and transferring documents between iPads.

### **Comments from the Students**

She found that most of the students enjoyed using the Apple iPads as a means for learning. Except for two students, everyone she talked to mentioned that the mobile practice websites worked well and were excited to use the iPads again in future courses. One student responded, "I enjoy using the iPad because I think it helps us more with our learning." Another student responded, "The practice websites worked well and made me learn the subject better." Another student commented, "Since I have iPad at home, learning to use them in class did not require any extra effort." Another student mentioned that "It is really quick to turn the iPads on compared to turning on a laptop."

### **Reflections from Ms. Bennett**

Ms. Bennett returned back to her room and reflected on her visit to Ms. Martin's classroom. The results from the pretest and posttest showed an improvement in learner knowledge of one-and-two-step inequalities. However, she realized that her one day visit could not accurately depict how effective the iPad technology was in the classroom for learning. Students were enthusiastic about using the Apple iPad in the classroom and also looked forward to using the Apple iPad in the future. A contributing factor to the excitement using the iPad in the classroom might have been because students enjoyed using something other than pen and paper. She also thought that the enthusiasm of the students could have been due to the novelty of the mobile device (iPads) in the classroom.

## ***Use of Apple iPads in K-6 Math and Science Classrooms***

She wrote a list (shown in Table 2) with the advantages and disadvantages of using iPads based on her observation.

### **Brainstorming Session with Mr. Pallapu**

Ms. Bennett wanted to find out how these instructional strategies (drill and practice, immediate feedback, and worked example demonstrations) help students. She scheduled a meeting with Mr. Pallapu. She met with Mr. Pallapu, the technology facilitator in his office the week after her visit. Ms. Bennett summarized the lessons she learned from her visit to Ms. Martin's class.

She wanted to know if there were additional resources that she can find out on integrating iPads in the classroom. Ms. Pallapu recommended her to follow the technology guidelines for science teachers while using the iPads (Flick and Bell, 2000):

1. Technology should be introduced in the context of science content.
2. Technology should address worthwhile science with appropriate pedagogy.
3. Technology instruction in science should take advantage of the unique features of technology.
4. Technology should make scientific views more accessible.
5. Technology instruction should develop students' understanding of the relationship between technology and science.

Mr. Pallapu also provided her with research on instructional strategies that guide the use of iPads in the classroom.

### **Worked Examples**

The iPad aids the teacher using a worked example approach to learning. A worked example is a step-by-step demonstration of how to perform a task or how to solve a

*Table 2. Advantages and limitations of using iPads*

<b>Advantages</b>	<b>Limitations</b>
Instructors can incorporate multimedia demonstrations in their lectures. Students can learn with it anytime and anywhere. Instructor can get immediate feedback on the lesson being taught. Real-time experiments can take place in the classroom.	Small screens limit the amount and type of information that can be displayed. Limited storage capacities for mobiles. Batteries need to be charged. Flash does not play on the iPads.

problem (Clark, Nguyen, & Sweller, 2006). The iPad utilizes this instructional strategy by allowing students to visit videos demonstrating on how to solve a particular problem. This instructional strategy helps students learn complex problem-solving skills. Sweller and Cooper (1985) found that learners who viewed worked examples required significantly less time during skill acquisition, and that these learners made significantly fewer errors during problem solving.

## Practice

Use of Apple iPads gives the learner the ability to do as many practice problems in a customized and individualized environment. Practice is often provided after learners have been introduced to new information required. Researchers have found that practice has a significant effect on performance (Gagne, 1985). Practice gives learners the opportunity to work through new material and strengthen newly gained knowledge, so they can recall and use it without assistance.

## Immediate Feedback

Practice provides an opportunity for feedback. Mobile learning provides instant feedback and confirms the student's answer as being correct or incorrect, and provides the reason for the incorrect answers. This feedback strengthens the probability of correct responses and reduces the probability of incorrect responses (Philips, 1998). Mobile devices make it possible for continual feedback throughout the learning process and provide learners guidance as to what might be improved and what comes next (Valk, Rashid, & Elder, 2010).

Mr. Pallapu helped her identify potential apps on science (shown in Table 3) that she could use in her middle school classroom (<http://www.ipadinschools.com>).

Mr. Pallapu added that the iPad has a number of unique features that provides additional opportunities in teaching and learning. He listed some of the ways in which an iPad can be used (Johnson, 2011):

- The iPad camera allows you to take pictures or videos of anything you see where ever you are. The Field Notes app only allows students to take detailed notes of their observations, it attaches the date, time, GPS location and photographs of what is observed. These notes can then be shared instantly.
- The iPads motion sensor allows students to use their hands in guiding the iPad to equilibrium, balance skills, or remote control of real or virtual robotics, hovercraft, or other vehicles. The clinometer app can be used for measuring the level of a wall or surface, and also the precise angles of incline or decline.

## Use of Apple iPads in K-6 Math and Science Classrooms

Table 3. Science apps for middle school

<b>3D Cell Simulation and Stain Tool</b>	Learn about the cell and its structures in a 3D tool.
<b>EMD PTE</b>	A highly interactive periodic table of elements.
<b>VideoScience</b>	Science experiments with video.
<b>The Elements: A Visual Exploration</b>	The Elements: A Visual Exploration lets you experience the beauty and fascination of the building blocks of our universe
<b>A Life Among Whales</b>	Video documentary featuring the exploration into the life and work of whale biologist Roger Payne
<b>Newtons Laws</b>	Explains Newton's first two laws of motion and his law of universal gravitation.
<b>Periodic Table of the Elements</b>	Standard periodic table of elements.
<b>Molecules</b>	View and manipulate 3D renderings of molecules.
<b>3D Brain</b>	Rotate and zoom around 29 interactive structures in the brain.
<b>Science Glossary</b>	An extensive glossary of scientific terms and biographies.
<b>myArm Muscles</b>	Visually rich and stimulating way to learn about our complex arm muscles.
<b>HD Birds Encyclopedia</b>	Highly graphic encyclopedia that has detailed and comprehensive information about a variety of birds.
<b>HD Marine Life</b>	An encyclopedia of marine life.
<b>Frog Dissection</b>	A virtual frog dissection app.

- The iPads internal accelerometers allows students to do physics experiments of acceleration where they can measure the change in force.
- When iPads are used in the same network but in different locations, students can create and collaborate using Assesmblee app.
- The GPS of the iPad can be used in a number of ways. Students can use the Map app to calculate the distances, compare routes, and participate in decision-making problems.
- The 3G connection in the iPads provides the students with access to internet anywhere they are.
- The Dragon Dicationation app types the words, when you dictate it to the iPad.
- Though the iPad's do not have USB ports or diskdrives, the cloud has been developed to share data with other computers. The Dropbox app allows one to store documents created using the iPad and access it from any other computer.
- There are apps such as Evernote to keep track of their notes, and apps such as Mendeley to organize their research documents.
- The teacher can walk around the classroom interacting with the students, and still control their computers from their iPad with the remote mouse app.

## **CURRENT CHALLENGES**

The iPads were not being used to their full potential in a number of classrooms. In this case, the iPads were just replacing the desktop or laptop computers in the classroom. Ms. Bennett wanted to find out more ways in which she can use iPads in her classroom, and incorporating the strategies and apps that Mr. Pallapu recommended. She thought that the iPads in the above case were used mainly for in-class activities. She wanted to find out other ways that she might be able to use the iPads both in-class and out of class, especially taking into consideration the mobility aspect of the device. She learned about the GPS, the accelerometer, and a number of apps that she can use in her Science classroom. She was ready to explore.

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## **KEY TERMS AND DEFINITIONS**

**Handheld:** Small and light enough to be operated while you hold it in your hands.

**Inequality:** An inequality is a relation that holds between two values when they are different.

**iPad:** The iPad is a tablet computer designed by Apple Inc. Its size is between that of a regular laptop and a smartphone.

**Mobile:** Able to move or be moved freely or easily.

**Mobile App:** Software application designed to run on smartphones, tablet computers and other mobile devices.

### ***Use of Apple iPads in K-6 Math and Science Classrooms***

**Mobile Learning:** Learning that occurs through the use of a wireless handheld device such as a cell phone, personal digital assistant (PDA), netbook, ipod or ipad to engage in meaningful learning in both formal and informal settings.

**Portable:** Able to be easily carried or moved.

**Wireless:** Using radio, microwaves, etc. (as opposed to wires) to transmit signals.

**Worked Example:** A worked example is a step-by-step demonstration of how to perform a task or how to solve a problem.