THE CHALLENGES OF INTEGRATING MOBILE TECHNOLOGY IN THE CLASSROOM EXAMINING AN IPAD PROFESSIONAL DEVELOPMENT PROJECT

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ABSTRACT

The iPad is a tool that could change the way in which teachers prepare and deliver instruction in the K-12 environment. But, while proponents tout its capabilities, school administrators run the risk of purchasing yet another tool without understanding its potential impacts on the teacher, students, and classroom environment. This study used iPads to implement a four-month professional development program aimed at helping teachers integrate technology into their classrooms. The iPads were deployed to classroom teachers in the science department at a suburban high school. Professional development was tailored to the teachers' interests, and was followed by individual interviews by the project leader. Results of the study showed that while teachers are open to new technologies, their focus is more on teaching considerations than on professional development. The study also indicated that teachers have difficulty considering incorporating a single device into a classroom of multiple students. It is recommended that this study be replicated, without the technical problems, on a larger scale and in subject areas beyond the sciences.

Keywords: Teacher Professional Development, Technology Integration, Mobile Technology, Tablet Computers, iPads.

INTRODUCTION

The use of technology by teachers in the classroom is not new, nor is the debate of its value (Mama & Hennessy, 2013). As smaller technologies, like handheld mobile devices gain popularity, they may be quickly looked at as a replacement for other technologies, such as desktop computers, laptop computers, digital projectors, and interactive whiteboards. While the literature is growing in terms of how tablet computers, such as iPads, are used among students, little research exists to depict how iPads affect teachers' professional development and teaching.

In 2013, the Horizon Report for K-12 (Johnson, et al., 2013) listed mobile learning with smartphones and tablets as significant impacts within one year or less. Most recently, national survey data from K-12 students noted that 21% of middle school students and 14% of high school students are using school-provided tablet computers (Project Tomorrow, 2015). In addition, 23% of middle school students and 58% of high school students reported that they are using their own devices, including laptops, tablet computers, and Chromebooks, in school for learning (Project Tomorrow, 2015). So, the use of mobile devices continues to increase in schools, and teachers must remain current in the skills needed to integrate these devices with meaningful teaching and learning.

iPads in the classroom are among the latest tools that allow for diverse interactions in the classroom (Ostashewski, Reid, & Ostashewski, 2011), such as video creation and just-in-time demonstration. With so many technological advances with iPads and other technologies, school administrators risk choosing a solution without teachers

being adept at using them. A survey of 357 school teachers found that technology is much more likely to be used by teachers when they consider themselves competent with the technology (Petko, 2012). This article presents the implications for practice of a four-month professional development program where iPads were introduced to high school science teachers.

1. Literature Review

1.1 Tablets and Mobile Devices

The nature of technological developments has allowed more powerful capabilities to become available on smaller devices. Tablets such as the Apple iPad were the first series of devices that provided the processing potential (and screen size) of a netbook (i.e., a low-cost laptop such as a Chromebook, that is primarily meant to run web-based services), but with the portability of a mobile device. Since the launch of the iPad, a number of other tablet computers have been deployed with Google's Android operating system, including Amazon's Kindle Fire and Samsung's Galaxy among others. A number of schools across the US are piloting tablet computers and e-readers as viable alternatives to print textbooks (Al-Mashaqbeh & Al Shurman, 2015; Ferlander, 2012; Gleason, 2012; Hu, 2011).

Early research with tablet computers continues to be sporadic and mixed. Grant (2015) noted that many implementations of mobile devices, like tablet computers, have been used to (a) increase access to student information and campus resources, such as library services; (b) increase interactions with learning and contents, such as practicing vocabulary and math facts; (c) creating representations of knowledge, such as creating short videos of mathematical concepts (White & Martin, 2014); (d) supporting face-to-face instruction, such as reviewing for exams with whole class games; and (e) deploying instruction, such as creating self-paced units (Grant & Barbour, 2013). There has been little confirming research determining the effectiveness of these devices on learning performance; however, there is some evidence that tablet computers can support many instructional strategies indicative of 21st century learning, such as active learning, student choice and challenges, cooperative learning, and technology skills (Burden, et al., 2012; Kearney, et al., 2015). Despite this, a recent report categorized a large percentage of literacy applications (apps) for mobile devices as being less inquiry driven and more focused on factual knowledge acquisition (Vaala, Ly, & Levine, 2015).

Some schools are also considering mobile devices, such as tablet computers, as financially viable alternatives to desktop or laptop computers (Kiger, Herro, & Prunty, 2012). Schools are experimenting with classroom sets of mobile devices. In one configuration, the teacher determines when the devices will be used (Bar, Weber & Pisani, 2016) and the students are unable to take the devices home or use them with autonomy (Grant, et al., 2015; Greenberg, 2010). Kiger, et al. (2012) described the use of handheld mobile devices and math software applications for third grade multiplication practice. The students practiced on the devices with specific applications during class and did not take the devices home. In many of these instances, the devices made limited use of the mobile capabilities and instead were a substitution for a larger desktop or laptop computer. In another arrangement, the students take personal ownership of the devices (White & Martin, 2014), and there is some evidence from tablets used in Scotland that this personal ownership is critical to learner autonomy and motivations to learn (Burden, et al., 2012).

Even without a device for each student, a single iPad can allow teachers to integrate technology on an individual basis. As teachers navigate the classroom to facilitate student learning one-on-one, the iPad allows them to quickly find a specific resource, display a simulation, or scroll to a specific section of an electronic book or website. Teachers can also collect and curate performance data as they observe students. Tablet computers and the iPad in particular have been considered devices that could change the ways in which teachers interact with their students (Parry, 2010). The appropriation of tablet computers by teachers offer numerous methods for integration (Bar, Weber & Pisani, 2016). Tablet computers have been also recognized as giving teachers new approaches to the teaching function, which could lead to improved students' learning experiences (McFarlane, 2013). Finally, they have also made it possible for users to

more effectively direct their own learning; teachers can also capitalize on this trend (Franklin, 2011).

1.2 Technology Integration

Following Davies and West (2014), technology integration is operationalized here as "effective implementation of educational technology to accomplish intended learning outcomes" (p. 843). For effective technology integration, certain obstacles must be removed from within a K-12 learning environment and other supports must be provided or cultivated. Barriers to technology integration are often described in terms of the types of resources (e.g., equipment, time, training, support) that are either missing or inadequately provided (Ertmer, 1999). Without adequate hardware and software, there is little opportunity for teachers to integrate technology into the curriculum (Hew & Brush, 2007). In addition to the physical resources required, teachers need hours to preview resources, websites, and applications, to locate software applications (i.e., apps), experiment with apps, determine scaffolding needed, and create examples.

In addition to hardware, software, and networks, meaningful technology integration requires teachers be provided with significant and purposeful resources and training. Barriers to training, resources, and support must be addressed for technology integration to be impactful to teaching and learning. Research has shown that teachers need both in-service training and ongoing curriculum support in order to be able to incorporate technology into the curriculum in meaningful ways (Brinkerhoff, 2006; Ertmer, 1999). Roschelle, Pea, Hoadley, Gordin, and Means (2000), Brinkerhoff (2006), and Ertmer and Ottenbreit-Leftwich (2010), corroborate Garet, et al. (2001) in that teachers should experience intensive and ongoing professional development. This professional development provides opportunities for modeling, practice, and experimentation. Moreover, professional development can help change teacher beliefs about pedagogy and technology integration. Teachers with more constructivist views of teaching and learning implement higher-level technology integration with a focus on student learning (Ertmer & Ottenbreit-Leftwich, 2010). With respect to science education, Wilkerson, et al. (2016), in their study examining the professional development on technology-mediated inquiry-based instruction found that, pre-service teachers focused heavily on modeling for exploring content and representing knowledge, rather than higher-order processes, such as hypothesis testing and revising schema. In addition, Kearney, Burden, and Rai (2015) found integration of mobile devices aligned with authenticity, collaboration, and personalization. So, by providing extended support and professional development, fears of failure can be reduced, teacher self-efficacy can be increased (Brinkerhoff, 2006), and shifts toward more student-centered uses of technology are possible.

Finally, the school culture cannot be overlooked when implementing technology integration. Silvernail and Lane (2004) and Grant, et al., (2015) suggested that administrative endorsement and supportive school cultures are needed to champion change. Ertmer and Ottenbreit-Leftwich (2010) advocated for administration to encourage teachers' efforts by supporting experimentation, and teachers can also feel supported even if they are "Lone Rangers" (Grant, et al., (2015), "Participant Descriptions" section, para. 2) within their schools, implementing emerging technologies in isolation.

1.3 Teacher Professional Development

Teacher professional development has been critical in preparing in-service teachers to meet the changing demands of their profession, as well as upgrade their knowledge and skills necessary to integrate technologies into teaching and learning. From the various extant literatures on teacher professional development, there is a consistent list of components that are recommended to effect the change in teachers' practices. These include (1) active learning, including hands-on instruction (Garet, et al., 2001; Lawless & Pellegrino, 2007; Mouza, 2002-2003), (2) alignment with specific curricular content and focus on pedagogy (Penuel, et al., 2007; Polly, Mims, Shepherd, & Inan, 2010), (3) collaborations (Vescio, Ross, & Adams, 2006; Rogers, 2000), (4) on-site support and just-in-time learning (Lawless & Pellegrino, 2007; Van Es & Sherin, 2008), (5) remunerations (Cole, Simkins, & Penuel, 2002), and (6) sustained learning opportunities over time (Garet, et al.,

2001; Howland & Wedman, 2004; Polly & Hannafin, 2010). These components have been researched independently in small combinations and in large scale studies.

When combined into a purposeful and thorough whole professional development effort, programs with these components are prospective for considerable change (Garet, et al., 2001; Penuel, et al., 2007). Much teacher professional development reflects brief, single presentations; however, research has shown there is a higher level of transfer in professional development initiatives when on-going support is provided to the teacher following an initial training (Desimone, Porter, Garet, Yoon, & Birman, 2002; Du Four, Eaker, & Du Four, 2005; Heck, Banilower, Weiss, & Rosenberg, 2008). Moreover, Scribner (1999) noted that using requirements and external motivating factors fail to ensure teacher engagement. Instead, teachers may participate only at surface levels, which may not influence their instructional practices.

2. Methodology

The purpose of this study was to examine the perceptions of experienced secondary science educators on the potentials and challenges of utilizing tablets in their day-to-day work procedures, classroom instruction, and professional development. A case study methodology was selected to address these questions (Stake, 1995). The case consisted of four K-12 science teachers in a suburban high school in the Midwest, each having more than ten years of classroom teaching experience. This project was a four-month professional development program that included group sessions, interviews, and classroom observations.

After purchasing the necessary iPads and accessories, the project leader led a focus group with the participating teachers. Teachers were first provided approximately 30 minutes to familiarize themselves with the iPads. They were then asked, (a) what they would like to learn about the device, and (b) how they could envision using it in their classrooms. Using this information, the project leader developed three monthly professional development sessions, which focused on topics discussed by the teachers; each session was designed to last one hour. They included, (a) a theoretical basis for the topic, (b) a presentation/discussion of the topic, and (c) an opportunity for hands-on learning with the iPads.

Throughout the study, ongoing support was provided by the project leader. Research has shown a higher level of knowledge transfer in professional development initiatives when ongoing support is provided to the teacher following the initial training – either by their colleagues or an outside support person (Desimone, et al., 2002; Du Four, Eaker, & Du Four, 2005; Heck, et al., 2008). The provision of this support after the initial professional development, along with the teacher involvement in the selection of professional development topics were both meant to increase the level of effective use of the iPad as a tool for technology integration by the teachers in this project. For example, because the participants were secondary science teachers, the researchers presented the teachers with several science applications (apps) related to their content areas. The initial orientation included an introduction to some science-related apps that had been preloaded on their devices (e.g., 3D CellStain, Molecules, Rocks, Tunnel Lite, Video Physics, Science@VL, several periodic table apps, etc.).

It was planned that teachers' classes would also be videotaped when they used the iPad in a manner consistent with a topic discussed in the sessions. However, only one of the four teachers felt confident enough with the device to attempt using it with his students. In this single instance, the teacher pooled together approximately a dozen of iPads from colleagues in the school and also encouraged students to bring in their own devices. He began the lesson by having the students to complete a quiz on their mobile device using the mLCMS Mobl21. This was followed by the teacher demonstrating a particular chemistry concept using a $1 USD app from his own iPad (i.e., QR Reference) and a document camera to project his screen to the class. After the demonstration, the students completed a set of activities using two free apps that had been preloaded on the iPads or that the students had been asked to download to their own devices (i.e., 3D Cell and VCell). The lesson concluded with the students completing a second quiz using Mobl21.

After the sessions, the project leader then met with the

teachers individually. These semi-structured interviews allowed the teachers to talk candidly about their use of the iPads during the study time period. They were then asked to recall their thinking during specific events within the recorded. The primary questions asked were:

1. What is one thing that you think went well with your use of the iPad in this class?
2. What is one thing you wish had gone differently with your use of the iPad in this class?

To answer these questions, transcripts from the interviews were coded using inductive analysis and constant comparative methods (Bogdan & Biklen, 2007) to develop themes in the teachers' perceptions of the iPad. In cases where a teacher implemented a lesson using the iPads, comparisons were made between the teacher's statements and the recorded lesson. The final list of themes were sent to the participants for review to further ensure trustworthiness of the analysis.

3. Results

As noted in the previous section, only one teacher felt comfortable using these mobile devices as the primarily tool in one of their lessons. Both the teacher and the students felt that this single mobile integration activity was quite successful, as the students were engaged and the teacher was able to integrate several different mobile learning activities into that single lesson. While this was the only formal class that was observed, all of the teachers reported that they made use of the devices within their professional contexts. For example, a couple of teachers made regular use of one of the periodic table apps (e.g., Memorex, AMC, EMD, etc.) as a reference when students had specific questions beyond the information contained on their paper copies of the table. The teachers felt each of these apps offered something a little different for the students.

After transcribing the interactions with participants and analyzing all the data, four primary categories clearly emerged, along with a variety of corresponding themes. Three categories addressed areas related to the affordances, challenges, and potential uses of iPads. A fourth category considered the professional development activities of the teachers. This section further reviews teachers' discussions about these categories and their related themes. All quotations below are verbatim comments from the participants, and they are uncorrected to represent most accurately their voice.

3.1 Affordances

Initial findings from this study indicated iPads brought a unique mix of affordances to the classroom and teacher. First, it offered a visual richness that teachers found particularly intriguing. They also allowed for more fluid classroom environments, where teachers could also move about the room more freely. The devices were also seen as a replacement to current textbooks, in large part, due to their enhanced features.

Teachers were impressed with the visual richness – the ability for animation, three-dimensional rotation of an object, etc. of the iPad, with one teacher noting that these capabilities benefit the classroom environment. That said, the most prominent in their focus on the visual appeal was in the apps available on the devices. They found a variety of visually stimulating apps that could be used specifically in their classrooms and subject areas. Some of these were simply interactive periodic tables, lab timers, and flash card builders, while others brought comprehensive features, such as satellite imagery, and 3D tutorials. A chemistry teacher mentioned projecting an app for the class where the carbon element could be clicked in order to see it in its many different physical states. Another teacher, referring to 3D imagery of the brain said, "you could peel away layers. That way students could learn the internal parts in sort of a more visual manner instead of just a 2D image".

In addition to the visual richness of the device and its offered apps, teachers found that using it helped to bring a higher level of fluidity to the teaching process. One teacher noted, "it creates capacity to be very fluid in what you're doing, because it's small. It's not something that has to be opened up, booted up. [You don't have to] sit down to use it; it's just a very mobile thing." Another teacher mentioned how iPads can access computers wirelessly through specific apps. This teacher noted that he could work anywhere in the room, making classroom management more fluid.

In addition to the iPad's fluidity as a result of its mobility and

ease of use, each teacher recognized the possibility of entirely replacing textbooks. A device like the iPad that can store extensive information and be transported so easily led one teacher to note that, "bound textbooks would be a thing of the past." How soon that would be is still unknown, but another teacher discovered that the current anatomy textbook used in his class was already available via iPad. He also discovered that the app-driven textbook allowed for a variety of laboratory-type activities that he indicated was highly interactive.

3.2 Challenges/Limitations

Though the teachers recognized a variety of benefits afforded by the iPads, these were also accompanied by as many challenges. The four most common limitations considered areas related to technology integration and product value vs. capability.

The use of technological devices in the classroom can be limited when there is not an appropriate level of integration with necessary school resources, particularly wireless internet access (i.e., Wi-Fi) and school administrative software. One teacher indicated that without Wi-Fi, a teacher is limited to the apps, and other information that resides on that device. This means there is no access to internet-driven apps, or even the internet at all. This prevents teachers from accessing all the resources they found beneficial earlier, including videos, interactive apps and the like. Another teacher urged districts to "support classrooms with wireless capabilities" so that teachers could make better use of the devices.

Without the device's ability to access the school Wi-Fi, integration with administrative software remained an issue. It was unclear as to whether this issue could be solved with access to Wi-Fi, but remained a concern for the teachers. Said one, "Our grading program and our attendance program are very rudimentary. They don't work well with anything but Internet Explorer". This limitation may have further prevented teachers from maximizing the device's capabilities.

The issues with technology integration may have exacerbated the iPad's negative perceived value and capability since the teachers couldn't fully utilize the device. That said, some teachers still noted that even when they did have Wi-Fi access, there simply were not the kinds of apps available that could be useful in some subjects. One teacher, who indicated she dedicated a lot of time to using the device, said the iPad was still a "novelty," and that it didn't bring real value into science classes that required lab work. Another teacher pointed out that the apps that were available often didn't align with the course curriculum stating that, "one of the difficulties is that you teach a particular amount of stuff and some of the stuff went into more depth and some of it into less depth. So you'd have to modify".

The general negative perceived value and capability of the available apps tended to be followed by a concern about the device's overall value vs. different solutions like a netbook or laptop. Most often stated was the desire to provide each student with a device, in which case netbooks would be less expensive.

One teacher noted the importance of the productivity aspect that is afforded by a netbook/laptop. Said one teacher, "you're basically looking at two laptops per iPad in terms of cost [which doesn't take into account] battery issues and drop issues." Another teacher said iPads were still just an "expensive toy," adding that providing netbooks to more kids makes more sense than fewer iPads for fewer kids since netbooks still allow for similar functionality. Teachers found a variety of challenges with the iPads, but also were able to see beyond the current situation to identify effective ways in which the devices could be used in the future. One vision for effective future use was that it could increase student interactivity and expedite their access to key information. Other recommendations were to use the device to make abstract concepts more concrete.

Increasing student interactivity during discussion was seen most often as a positive future use of the iPads. One teacher, considering the device's mobility saw value in handing over the iPad "controls" to kids when projecting on the screen. He said, "If I was lecturing, I could walk around to show people some things and hand it to a kid and say 'style this or change this feature.' Then everybody could see what the effects of that were." Another teacher agreed stating that handing the device over to a student during a class lecture to perform a task adds a functional element to the

session. These teachers noted this activity would allow more interaction and provide an opportunity for kids to actually "do something" during a discussion.

Quick access to information was also identified as a potential value for students. With access to Wi-Fi, one teacher pointed out the benefit of accessing better information more quickly as opposed to, "having to reserve the lab or having some netbooks in the classroom." Another teacher believed that iPad access was a much quicker way to access information, especially when students needed key pieces of information in order to find a solution to story problems.

In identifying their current challenges in the classroom, the teachers noted that the use of iPads could help to make many abstract concepts more concrete. One teacher envisioned simulating the results of chemical experiments using apps to show how certain chemicals react without having to actually use chemicals. In reflecting on his science class challenges, another teacher noted that when working with topics on the cellular and molecular levels, animation and simulation help students better understand abstract concepts.

3.3 Professional Development

One of the primary goals of this study was to determine how teachers perceive potential uses of iPads in their own professional development. By far, the most common professional development activities taken on by these teachers were discovery and lesson preparation. They also commented on the iPad's place in classroom administration.

Teachers using the iPads used it mostly for discovery/brainstorming and lesson planning. While the discovery activity could have simply been a result of the fact that the devices were new the teachers, most indicated they delved into the functionality of apps and resources to identify ways to improve their classes. Said one, "A lot of what I did was just try to see what was available, I enjoyed checking out some free applications. I spent a lot of time surfing the internet to see how other people were using the iPad for education, and in an educational setting. I wanted to come away with some real ways of using this actively in the classroom with my students and real ways I could use this tool to make my own personal/teaching life more fluid."

This discovery activity taken on by the teachers also led them to apply what they found during actual lesson preparation. Comments indicated using iPads for lesson preparation, (a) allowed for quick access to examples to show in class, and (b) was effective as a reference tool while planning.

In addition to discovery and lesson preparation, teachers commented on the potential ability to use iPads for class administration. With more time and training on the device, one envisioned using it to "do things like take attendance and various things with the iPad from anywhere within the room." While there wasn't consensus about the use of iPads in class administration, this may be a result of lack of Wi-Fi access and other support in the classroom.

Results of this study show there are various opportunities aligned with the affordances and potential future uses of iPads in the classrooms for teachers. On the other hand there are a variety of challenges relating to current limitations in the device's capabilities and perceived value. These challenges may further limit the existing professional development opportunities for teachers.

4. Discussion

Unlike most research that focuses on the use of iPads among students, this study explored the use of iPads by teachers rather than exclusively in a classroom setting. The most significiant findings are discussed below and address technology preparation and professional development. These findings are, for the most part, consistent with the literature described earlier.

The teachers were initially impressed with the functionality of the iPad and its ability to present science concepts in a highly visual manner. In line with McFarlane's (2013) findings, the participants saw the possibilities to change the instructional process. Even with a single device, students struggling with an abstract concept could benefit from a teacher showing them a visual representation on the device. However, the teachers' perceptions of changing the instructional process could be questioned, as many of the comments were restricted to demonstrating concepts and information retrieval rather than enabling higher-order

thinking exercises (Burden, et al., 2012; Wilkerson, et al., 2016). Given the revisions to national science standards in the United States, which focus more on scientific processes and inquiry rather than memorization of facts, it became obvious that these experienced teachers, were having difficulty moving away from their preferred methods of instruction and evaluation (i.e., lecture and demonstration followed by testing). Even considering the teachers' comments on the device replacing textbooks, one could wonder about their pedagogical use of textbooks and whether the switch would merely emulate rather than alter current practices. It is possible that future professional development should extend beyond the basic quiz, game, or reference apps and tie directly to subject-specific pedagogical strategies for promoting critical thinking and other higher-order processes, as supported by Brinkerhoff (2006), Ertmer (1999), Ertmer and Ottenbreit-Leftwich (2010), and Roschelle, et al. (2000).

Many of the criticisms and obstacles mentioned by the teachers mirror the literature on barriers to technology integration (Ertmer, 1999; Hew & Brush, 2007). The lack of wireless connectivity in the school severely limited the ability of the teachers to fully utilize and appreciate the device. Further, the teachers lacked the ability to connect the device directly to their LCD projector without a crude and unwieldy wiring scheme. Thus, while a teacher could use a singular device to help a small group of students, they lacked the ability to demonstrate a concept to the class as a whole with the device.

Finally, with respect to culture, even as we intended to limit our provision of technology to teachers. So, the researchers could minimize negative impacts, and limitations that made it more difficult for the participants to succeed. Even in a somewhat controlled study, it was clear the teachers lacked the technology support they needed. Their disdain for the state of technology in the school (e.g., the lack of wireless connectivity, archaic student grading and attendance software, etc.) indicated that the school and district lacked the means to support technology in ways necessary to promote deeper technology integration. Combined with a possible lack of interest in exploring or promoting technology for transforming instruction, there was no indication that technology integration was tied to learning outcomes (Davies & West, 2013). As such, perhaps technology was seen as supplementary, and with little administrative support (Ertmer & Ottenbreit-Leftwich, 2010; Grant, et al., 2015), novel technology use in the school occurred in isolation.

In summary, it was clear that the teachers in this study had their curiosities piqued by the concept of using the iPad in the classroom. Their initial thoughts centered on possibilities on its use with respect to current practices. However, over the course of the study, infrastructure barriers became a deterrent, and the teachers became more critical of the devices. Further, the lack of infrastructure portrayed a lack of support for teacher technology use, and, as a result, a possible lack of professional development not only for technology, but for the associated instructional strategies to promote 21st Century skills.

Conclusions and Implications

Technology is often looked as an effective tool for the classroom. However, teachers and students may be ill-prepared to maximize its use. Teachers in this study participated in professional development sessions to increase their ability to integrate the new technology, like iPads into the classroom. While results showed a variety of limitations, the teachers identified many uses for the tool in the classroom. Undoubtedly, the biggest challenge the teachers faced was accepting the idea that they would be the only person in the classroom with the device. However, this approach was effective in that it encouraged the teachers to consider the iPads use differently than they had previously. Results of the study show there is an array of future possibilities in terms of how iPads and other mobile devices might be used by teachers, but that additional research is imperative.

There was a lack of focused professional development by the teachers in this study–outside the sessions. Their immediate teaching functions simply took priority over real growth opportunities. That said, the length of the study likely contributed to this. It would be beneficial to extend any studies that include professional development sessions. A future study could also benefit by additional teacher support for the tools.

Based on the limitations of and additional findings in this study, a variety of potential study areas have surfaced. It would be useful to conduct a similar study, ensuring all participants have Wi-Fi access for their devices and have the necessary accessories to utilize these devices. It would also be beneficial to use literature on current educational apps, and then conduct a focus group asking teachers to try to incorporate those as a team into a class. Measuring the success rate in terms of knowledge transfer or student motivation would likely provide valuable information.

It may also prove fruitful to conduct a study similar to this, but of only physics, chemistry, or biology teachers from a variety of schools. In the focus groups, these subject matter experts may find more inquiry-based strategies for using the iPads effectively in the classrooms. They may also find more innovative approaches that they could further develop and incorporate. Their perceptions and the students success could then be measured.

This study found the teachers focused on the teaching aspect of professional development. The reserachers propose that professional development, unrelated to the teaching aspect be studied. The more confident teachers feel with the devices and their own capabilities, the more likely they may be to incorporate them into classes.

The findings in this study have important implications for technology implementation in teacher professional development and the K-12 environment. By providing professional development opportunities using technologies being considered for an entire classroom, schools can better understand the potential challenges and benefits of the investment. Furthermore, the teachers' exposure to such technologies will further the possibility that the teachers will embrace and more effectively utilize the tools.

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