

The Highs and Lows of Mobile Digital Technology Integration in Kindergarten

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Abstract

This two-year research study examined 27 kindergarten educators' professional learning experiences using open-ended tablet applications to support children's (aged 3-6 years) oral and visual literacy learning. In contrast to typical professional development initiatives, the educators in this study were treated like professionals with control over how the apps would be integrated into their daily pedagogical practice. The research team functioned as technical advisors, observers, and resource providers. Research team members ascertained educators' levels of confidence, experience, and interests through regular interviews, questionnaires, and bi-weekly classroom visits. Annual workshops provided opportunities for educators to reflect and share insights. Over the two years, the educators experienced a series of highs and lows in response to their particular contexts. While they were initially confident about introducing the apps in their classrooms, technical and environmental challenges soon led to frustration. With time and on-going support, educators worked through a series of challenges to develop deeper understandings of the technical and pedagogical issues related to digital technology (DT) integration. They came

to appreciate the learning and teaching benefits of the apps, which provided them with additional tools to support children as they created, documented, and reflected on their learning. Moreover, the educators began to use the children's digital work for assessment and planning purposes. This study illustrated how teacher learning in DT integration is complex and non-linear, with different competencies and needs for support coming to the fore over time.

Key Words

Early childhood, professional development, literacy, digital technology, iPad apps

1. Introduction

It can be difficult for early childhood educators to know how and when to incorporate digital technology (DT) into their literacy programs for young children. They are faced with contradictory messages about DT use with young children. Some research reports that it can lead to children being solitary, sedentary, and passive (e.g. NAEYC, 2012; Radesky, Schumacher & Zuckerman, 2015, Council on Communication and Media, 2016), but also that it can create opportunities for children to be creative problems solvers, to work collaboratively, and to be ready for our technology driven society (e.g., Roswell & Harwood, 2015; Falloon & Khoo, 2014).

Educators are required to teach literacy in ways they did not experience as students, and most likely did not learn about in teacher education programs (Chen, Gallagher-McKay & Kidder, 2014; Darling-Hammond, 2006a, 2006b; Kirkwood, 2009). Professional learning opportunities for early childhood educators in this area are limited. Educators learn little in their pre-service education programs, and the few opportunities for in-service learning are often brief

and lack the in-depth knowledge and skills needed to integrate DT into their classroom programs successfully.

This Canadian research study was funded by a federal research grant that focused on partnerships between colleges and social agencies (including public school districts) for the purpose of social innovation. Our college and a local school district began our partnership in 2015. The partnership came about due to a joint interest in investigating the learning possibilities of digital technology for young children. This study is an outgrowth of that partnership. This study proposed a flexible and responsive approach to teacher learning in DT. The research team was comprised of a professor in a local Early Childhood Education pre-service program and her current and former students. The research team and the early childhood educators participating in the study, some of whom were graduates of the same program, worked together to design many aspects of the study. The early childhood educators working with kindergarten children in two school districts near the college were given iPads loaded with open-ended apps and on-going support, but were encouraged to use their professional judgement to guide their practice. The educators let the researcher know what types of supports they needed as the study unfolded. The research team was responsive to the needs of the children and teachers over a two-year period, working with app developers, creating tip sheets, and providing learning opportunities as needed. The research team and the participants together discovered that teacher learning is complex and non-linear, with different competencies and needs for support coming to the fore over time.

This chapter reports on the first two years (2015/2016-2016/2017) of a three-year research study examining the use of open-ended iPad apps to support young children's literacy learning in 14 full-day kindergarten classrooms (ages 3-6) in Ontario, Canada. Literacy in this study is defined broadly, as meaning-making in multiple forms including visual, oral, print, and

digital. Literacy activities in these classrooms are often social and collaborative in nature, and integrated into play and content areas such as math and science. The curriculum for kindergarten in Ontario, *The Kindergarten Program* (Ontario Ministry of Education, 2016) advocates a play-based approach to learning and teaching. It states:

Play is a vehicle for learning and rests at the core of innovation and creativity. It provides opportunities for learning in a context in which children are at their most receptive. Play and academic learning are not distinct categories for young children, and learning and doing are also inextricably linked for them. It has long been acknowledged that there is a strong link between play and learning for young children” (Ontario Ministry of Education, 2016, p. 18).

The classrooms in the study were situated in two large urban school boards in Ontario. The children come from families that are culturally, linguistically, and economically diverse. Children enter the kindergarten program in the year that they turn four, and stay for two years. The iPad apps used in this study, *30 Hands* and *Explain Everything* are open-ended. They offer a range of visual recording options including drawing, photo, and video functions, as well as audio recording. There is no content other than a few background scenes, and the apps are not designed to teach any specific skills. These open-ended apps complement a play-based approach to learning and teaching. All children were able to explore and document their learning in ways that met their individual learning needs through the multimodal tools provided in the iPad apps. The research question that governed this study was: How do early childhood educators in a DT research project experience professional learning?

2. Literature Review

Several recent studies describe how mobile DT, such as smartphones and tablets, are

being used to support young children's literacy learning at home, to assess understanding, and to create a school-to-home link (Blagogevic et al, 2012; Neumann, 2016; Radesky, Schimacker & Zuckerman, 2015; Wong, 2015). See Chap. #: Mobile devices for preschool-aged children, and, Chap. #: 1:1 iPads in 1st Grade: Two-Year Case Study of a Teacher's Concerns and Implementation. While some studies have examined the use of eBooks, games, digital drawing pens (Lee et al, 2017), augmented reality toys (Yilmaz, 2016) and learn-to-read apps, studies that report on the use of open-ended iPad apps in school environments are emerging (e.g., Fleer, 2014; Herro, 2015). In fact, several studies (e.g., Roswell & Harwood, 2015; Falloon & Khoo, 2014) illustrate how literacy acquisition, expression, development, and consolidation are being redefined through DT.

The increasing complexity of how we communicate as a global society means that we need highly skilled teachers who have a broad definition of literacy, can incorporate digital technologies (DT) into their learning programs, and recognize that literacy is rapidly evolving. However, currently pre-service and in-service professional learning offer little guidance on the appropriate use of DT in early childhood programs. As a result, many early childhood professionals report uncertainty about how and when to use DT in their early childhood classrooms (Beschoner & Hutchison, 2013). For example, although there are hundreds of mobile applications claiming educational value, few reflect principles of constructivist learning necessary for young children (Goodwin & Highfield, 2012). Without a secure foundation of knowledge to evaluate and integrate technologies, early childhood educators may struggle to incorporate DT. Early childhood educators need better support at both the pre-service and in-service stages.

While the need for pre-service support has been identified (Darling-Hammond, 2006b), little progress has been made to achieve that goal. Research offering pre-service guidance is not always delivered in an effective manner. Laffey (2004) found that even when pre-service early childhood teachers (ECTs) attended an educational institution with a mandate for integrating technology, they found little value or use for DT in their practice. However, when ECTs had practicum experiences involving successful DT use, they saw more potential for using the technologies with young children (Laffey, 2004). By 2016, Brown, Englehardt and Matthers found that DT was more appealing to pre-service ECTs, but these educators continued to struggle with how to use DT in developmentally appropriate, child-centric ways. Without explicit guidance and practical experience, pre-service ECTs defaulted to using DT solely for documentation or “didactic instruction” (Brown et al., 2016, p. 179). The field needs further research to determine which supports effectively prepare pre-service early childhood professionals to use DT in their classrooms.

There is also growing recognition of the need for ongoing professional learning opportunities for in-service early childhood professionals. Parette, Quesenberry and Blum (2010) caution that failure to pursue DT-supported education may result in educators “missing the boat” (p. 335). While some institutions capitalize on the potential benefits of DT, they may only provide digital materials without accompanying pedagogical or technical support. Blackwell, Lauricella and Wartella (2014) highlight the need for further support, noting that “technology in and of itself may not have the inherent power to change teaching and learning practices” (p. 83). Ertmer and Ottenbreit-Leftwich (2013) likewise argue for the need to change the “focus from technology integration... to technology-enabled learning” (p. 175). Implemented alone, DT tools are insufficient; they must be accompanied by intentional strategies to be effective.

Due to demand for DT support in early childhood settings, researchers have begun to experiment with different models of professional development. Keengwe and Onchwari (2009) designed an eight-week summer intensive, which involved a series of workshops to help early childhood teachers plan appropriate DT curriculum. While they found some improvements in the teachers' planning abilities, none of the participants reached exemplary levels; this was possibly due to the brief nature of the program (Keengwe & Onchwari, 2009). Chen and Chang (2006) tested a longer-term professional development program that aimed to support the "whole teacher" (para. 1), including their "attitudes, skills and knowledge, and practices" (para. 1). This approach was more effective than the short-term workshop experienced by the control group (Chen & Chang, 2006). Fisher, Frey and Nelson (2012) also recommend long-term professional development opportunities that provide guidance for curriculum planning in addition to pedagogical implementation. Other researchers suggest that professional development models must target particular skills to be most effective.

Blum, Parette, and Watts (2009) identified four competencies necessary for effective and sustainable technology practices in education:

- 1) the ability to use the technology (operational competence - how does the app work?)
- 2) the ability to apply the technology in the classroom (functional competence - storing, charging, displaying, class management, sharing)
- 3) an understanding of how the technology fits into the curriculum (curricular competence - how does it support learning?)
- 4) the ability to use effective instructional strategies (instructional competence – how do I teach with it?) (Blum et al, 2009)

Educators demonstrate these competencies after participating in user groups supported by ongoing professional development (Parette, Quesenberry & Blum, 2010; Keengwe & Onchwari, 2009).

While developmental skill-based models of professional development remain popular, other researchers note the limitations of this approach. Laffey (2004) explains that:

Teachers' adoption of technology has been most frequently treated as a linear movement from an entry level of developing awareness through appropriation and innovation, in which teaching roles and practices are transformed (CEO Forum, 1999; Dwyer, Ringstaff, & Sandholtz, 1991). The sociocultural framework suggests that the path is not simply linear and that tools may be mastered but not appropriated, appropriated for some roles in some contexts while not in others, and that it may be more useful to see appropriation as not simply a psychological or individual stance but rather a stance within a context.”(Laffey, 2004, p. 363)

Pacini-Ketchebaw et al (2015) also challenge the assumptions made in traditional professional development, including the notions that it is a neutral, passive even, is “linear and sequential” (p. 67), that the educator is a stable, unchanging subject, and that change occurs solely in isolated and pre-planned increments. The current study offers an opportunity to both explore and challenge these models of professional development.

3. Methodology

This paper reports on the first two years (2015/2016-2016/2017) of a three-year study of 14 kindergarten classrooms in Ontario as they used open-ended tablet apps (*30 Hands* and, to a lesser extent, *Explain Everything*) in their play-based programs. Each classroom of participating teachers received three iPads used most often during open-ended activity time, outdoor play, and more focused literacy activities. Most classrooms had two educators (27 educators in year 1 in total, and 25 educators in year 2 in total). The educators, Registered Early Childhood Educators (RECEs) and Ontario Certified Teachers (OCTs), participated in interviews before the study began to determine their experiences with DT and their attitudes towards using DT with young children. At the end of the first year, each teacher again participated in an interview to ascertain if their attitudes towards using DT with young children had changed, and to learn about what they perceived to be challenges and benefits of using the tablet apps in their programs to support literacy learning. At the beginning of the second year, they completed a questionnaire on similar topics, and at the year's conclusion teachers participated in an interview for the last time. Interviews were recorded and transcribed.

All educators attended a focus group/workshop each year. During the focus group/workshops, the educators were asked about the challenges and learning opportunities they and the students were experiencing. They then reviewed their students' digital slideshows on their classroom iPads and shared their evaluation of them with their peers. Finally, they participated in technical and pedagogical challenges to increase their levels of comfort and familiarity with the apps. Detailed notes were taken during the focus groups.

Members of the research team observed the teachers and children bi-weekly using participant observation. Research assistants (RAs) were all qualified early years educators or educators-in-training. Under the classroom teachers' direction, RAs also worked with small

groups of children during these bi-weekly visits to help with technical issues and to model supporting students as they used the apps. Students had individual accounts within the iPad apps where they could archive their slideshows. Samples of student digital slideshows were collected and analyzed. All children's names are pseudonyms.

The research design was emergent. While we gave the educators some basic training on the use of the apps, we did not train the educators on specific pedagogical strategies nor did we ask them to teach specific skills. We observed and listened to the educators and children in order to provide the support that they needed. For example, when the app *30 Hands* proved problematic at first, we worked with the app developer to change the app to make it easier for young children to use. In addition, when the educators asked for specific technical or pedagogical information, we created and provided those resources.

4. Findings

Pre-Implementation High

Interviews conducted with the educators prior to the implementation of the project revealed that there was an overall positive attitude toward using the open-ended iPad apps in their classrooms. When asked about the degree to which they felt DT has the potential to support literacy learning for young children, 96% of the educators responded that it had a 'good' or 'great' potential. When considering the ways DT may be useful as a classroom support, one educator stated:

I think I would benefit from it immensely just in terms of my relationship with the kids, in being able to help them, being able to guide them, and keep them engaged in something that's relevant in their world now .(Educator, Year One)

Evidence indicates that using DT in the classroom was pertinent to young children and educators through supporting their professional practice. Additionally, there was a high level of comfort among the educators when asked about their ability to implement DT effectively into their classroom teaching. Pre-implementation interviews illustrated that 73% of the educators in the study felt either comfortable or very comfortable using DT for teaching literacy to young children. They were eager to begin the project and expected that it would be quite straightforward, as illustrated in the following quote:

Once they have access to them [the apps] and they're free to do whatever they want and explore, they will become more confident and we can direct them with the right usage. They will be prepared to be alone with the device. (Educator, Year One).

Participants may have reported high self-efficacy due to their own use of, and proficiency with, DT in their personal and professional lives. Many of these educators were already using computers, iPads, digital projectors, and digital cameras in their classrooms. However, the use of these DT devices by their students was very limited. This prior experience and knowledge, coupled with the excitement related to having new devices and added classroom support from the researchers, contributed to their readiness and comfort to engage with a DT project in their kindergarten classrooms.

Early Reality Check

While this high level of self-efficacy was beneficial to the launch of the project, it was soon evident that both the educators and researchers underestimated the multiple and complex elements that implementing open-ended iPad apps in kindergarten classrooms entail. Many of

the early challenges were related to technological issues, some of which were due to glitches in the free version of the first app that was first introduced, *30 Hands*. Furthermore, the app had appeared simple upon first glance, however some children required significant adult support while they became familiar with the various features and the multiple steps required to navigate within the app. In the context of a busy kindergarten classroom, the educators were not always able to dedicate the one-on-one time required for the type of support the children needed. While they were appreciative of the individual and small group support the research assistants were able to provide during bi-weekly classroom visits, it was apparent that many children required consistent and ongoing assistance to learn how to operate each of the features within the app before they were prepared to engage with it independently.

It quickly became clear that routines to promote the integration of the iPads into the classrooms would be necessary to ensure sustained and positive experiences for the children and educators. Beyond trying to arrange for the one-on-one and small group support for the children, educators needed to consider how and when to charge the device batteries during a busy day, and in classrooms with limited electrical outlets. Furthermore, educators identified social challenges related to the iPad apps. Children's excitement and interest in the new digital tools contributed to disputes related to turn-taking and sharing with their peers. Children were enjoying taking photographs and drawing simple pictures on the iPads, and this made it challenging for them to hand the device over to another child at the end of their turn. Additionally, educators expressed worry that the novelty of the iPads meant some children were less likely to engage with the other materials in the classroom.

Overall, these concerns, in addition to the time and planning required to support effective use of the iPad apps, created problematic situations for the educators. The educators' self-

efficacy, which had initially been quite high, was disrupted by the many challenges they faced. This led them to question themselves and the value of the technology itself. The researchers found that their role at this stage encompassed more troubleshooting than observing, as they worked with the educators to problem-solve the multifaceted issues.

Drawing on the four competencies model of professional learning in DT presented by Blum et al. (2009), it became apparent that proficiency in each of the competencies (operational, functional, curricular, and instructional) encompassed a number of factors that were neither linear nor static. The initial excitement and desire to ‘get to work’ that can often accompany a new project appeared to contribute to a simplistic view that it would be quick and easy to attain basic competency. The educators and researchers were unaware of the fluid and cyclical nature of the process of integrating DT into the classrooms.

During the first six weeks, there were many unexpected challenges that arose for the educators, the children, and the research team. The primary focus during this time manifested in the operational and functional competencies identified by Blum et al. (2009). The need for immediate working knowledge of the apps, and routines and procedures for introducing them into the classroom took precedence over a deeper examination of curricular and pedagogical issues. It became clear that the DT integration process was not as simple as it may have originally seemed.

In spite of the challenges, the children were learning to use the open-ended app in basic ways such as drawing with a single colour and taking photographs. In order to create the slide depicted below as in Figure 1, Alicia (age 4) had to open the app, choose the blank slide option, choose the drawing tool and create the drawing with a finger.



Figure 1 Alicia's drawing from this study

Phase 3: Crawling Out of the Hole



Figure 2 Teaching mobile devices

Despite the early hurdles in the first two months of the year, educators and the research

team persisted and began to devise strategies throughout the fall. To address structural challenges such as limited space to keep the iPads powered, educators were provided with cube-shaped outlet extensions, which allowed for charging multiple iPads concurrently. Charging stations (depicted in the photo above) helped educators to make the most of the limited space available in their classrooms. Educators also began formulating consistent routines to ensure that the iPads were charged and ready for action. Locked storage spaces kept the devices safe when the educators were not present.

Technical glitches were an ongoing source of frustration for adults and children alike. These were met with a sense of determination and a willingness to problem-solve at this point. The research team took on the role of technical support, helping educators reboot the devices when there were minor glitches and frozen apps. As educators came to understand the apps more, they became more adept at navigating the many features provided without as much reliance on the research team.

While social challenges were difficult at times, educators established routines around sharing and turn-taking to help the children self-regulate. For example, some educators divided the children into three groups corresponding to each of the class' three iPads. Others set time limits to ensure all interested children could get a chance to use the iPad that day. Educators also helped children learn to ask permission before taking photos or videos of others. Another early challenge was children's tendency to explore and draw over their peers' files. To address this challenge, educators helped children to respect others' digital work in the same way that they would respect a physical drawing. With help from their educators, children quickly adapted to these expectations. One educator recalled,

[Children] were actually really mature using the iPads, more than I expected. I was really

nervous about them having the iPads to begin with. Like we talked about the rules.

“Make sure you are careful.” But you wouldn’t believe how responsible they actually were with the iPads. So they took ownership of their work when they were using them.

They let other kids use it if they were having their turn. They would wait for their turn.

There was no fighting, which I expected to happen. They knew their colour group. They knew if somebody was using it then they would ask for a turn, wait, and they were really excited about seeing other people’s work as much as their own. (Educator, Year One)

As educators gained experience facilitating digital activities, their understanding of pedagogical strategies shifted in response. Many experimented with making the iPads easily accessible to children by strategically placing the devices near intriguing table activities.

Furthermore, educators observed how children interacted with the iPads, and used these observations to inform future curriculum planning.

There were several factors contributing to the educators’ ability to strategize those early challenges. For one, educators had built enough operational and foundational competence (Blum et al., 2009) with the apps that they were able to increase their sense of self-confidence and self-efficacy. The research team’s biweekly visits also contributed to educators’ understanding, since educators were receiving frequent, ongoing support and modeling. Another factor was seeing firsthand how children were demonstrating deep literacy learning through their technology-facilitated explorations. Not only were children learning skills themselves, but they were also taking on leadership roles to support their peers. One educator remarked,

[I]t was just really positive to see that they were so proud of what they could do. And the way that even the ones that at the beginning couldn’t even navigate it, couldn’t figure how to work the app they were just like figuring it out and then teaching other kids. So I

really like to see the partnership and the teamwork that was happening, they were really supporting each other. (Educator, Year One).

Finally, educators were more motivated to strategize solutions when they saw the potential value of the apps and their pedagogical applications. Through discussions with the research team and observations of children in their own classes, educators developed an increased awareness of how technology supported literacy teaching and learning. While operational and functional competencies continued to be present at this stage, curricular and instructional competencies became more prominent (Blum et al., 2009).

Phase 4: Continued High - Exploring, Sharing & Celebrating



Figure 3 Slide made by students

The winter and early spring brought a period of excitement and more in-depth exploration of the apps. The slideshow above is an example of the more complex work the children were creating during this time. For this slide, Jaspreet (age 5) documented a structure he had made by photographing it and then labelling it using the tools in the app *30 Hands*. He used phonetic spelling to describe what he had built, “Des is a letal cassol” [This is a little castle]. Documenting structures made during open-ended playtime was a popular use of the iPad apps during this period. This slide represents far more technical skills than the drawings the children were making earlier in the year, but also a more complex and detailed representation of the child’s thinking. The children in the project moved beyond experimenting with what the apps could do, to beginning to use the tools within the app to represent ideas and images that were important in their world.

A focus group/workshop in the early spring of the first year brought heightened enthusiasm for the project. Educators from multiple sites were brought together to share their joys and frustrations, which enabled collaborative sharing and learning. Educators helped each other problem-solve common issues from each of their sites, keeping an open mind and exercising patience in the face of challenges. The opportunity to share examples from their own classrooms contributed to an increased sense of pride on the part of each of the educator teams. As well, hearing about similar challenges from other sites helped educators realize that they were not alone in their struggles. They began to view challenges optimistically, realizing that it was simply part of the learning process for everyone. Within this community of learners, educators felt a sense of agency and collaboration. Looking back on this focus group/workshop one year later, an educator commented:

I know the workshop was really good. Listening to how, and seeing how, other centres

put the program to use is really neat, 'cause all of our minds work differently, it's kind of like the children. We all think differently, and seeing how they're able to put the program to practice, and put it into use, then it's - ideas that we can incorporate. (Educator, Year Two)

Factors influencing this high point in the project included the focus group/workshop itself. It provided educators with time for support, learning, comfort, and reflection as they shared examples and worked together through challenges. Furthermore, the focus group/workshop gave the educators a chance to play and experiment with the technology in a concrete way, which inspired exploration of the device's possibilities. While the educators were already creative, collaborative, problem solvers in other areas of their programs, the focus group/workshop provided a safe environment for them to apply their professional knowledge and skills to the area of digital literacy learning.

Year-End Fatigue: What now?



Figure 4 Student's work in the end of year

The end of the school year in late spring brought some unexpected challenges. The novelty and initial excitement around the iPad apps appeared to have worn off. The educators

and the children were less enthusiastic about the iPad apps, and the children were using them less frequently. When they did use them, the children seemed to have plateaued. Once they had discovered how to use the visual and auditory tools within the apps, they seemed to lose interest in continuing to use them as thinking tools, either leaving them sitting on the counter or using them in silly ways. This may have been due to end-of-year fatigue, or uncertainty on the part of the educators and children about how to proceed once basic proficiency had been reached. Many children began trying to exit the open-ended apps to access other apps on the iPads that were more game-like.

During the interviews at the end of Year One, educators reported that they felt that they had needed some new programming ideas for the apps. Many said that they were comfortable supporting the children in the basic functions of the app, and in encouraging them to document their work, but they were ready to move on. As the educator below put it, she had “gotten into a rut” and needed “creative ideas”:

I definitely would like to move it from being a piece of furniture in my room to more of a vital part of my room. And I would like more support for creative ideas... because I kind of felt by the end I had gotten into a rut, like we just put it out and reminded them to document what they were doing. There's got to be other things I could do with it, that I maybe hadn't thought of.” (Educator, Year One)

She recognized that the iPads, which had been a source of great excitement at the beginning of the year, had become merely “a piece of furniture”. Like the educator below, she recognized that she needed to try new strategies:

I think maybe I need next steps for it because I feel like we've gotten to the point of 'let's document and share it'. I want to figure out another way that I can use the app besides

maybe just documenting their projects, so if there are other suggestions of how to use it, that will be good.” (Educator, Year One)

Both of these educators, and many others, asked for a workshop, technical tip sheets, and teaching ideas in the following year to help them to expand the use of the iPad apps in their programs.

By the end of the first year, both the children and educators were feeling quite comfortable with the basic functions of the apps (operational competency), and the storing, charging, and sharing routines (functional competency). The educators reported that the apps were supporting the children’s literacy learning and development, particularly their oral literacy (curricular competency), but they sensed that the apps held a greater capacity to support their students’ learning than they had yet been able to realize. They recognized that what was needed next were resources to expand their repertoire of DT teaching strategies (instructional competency). Earlier in the year the strategies that were in place (e.g. free exploration) were appropriate and sufficient for educators and children to learn how to use the apps, but now they needed more complex teaching strategies to support more complex use of the apps.

Flying High Again: Beginning of Year Two

At the beginning of the second year, the educators were very positive about the iPad apps for both teaching and learning. According to a questionnaire administered early in the year, 87.5% believed that they had the technical knowledge they needed to use the app *30 Hands* in their kindergarten programs, and 75% reported that the app fit their image of ‘best practice’ for literacy teaching and learning in kindergarten. However, in keeping with their interviews the previous spring, only 62.5% felt able to plan effective literacy activities with the app.

In response to the educators’ request for more pedagogical leadership from the research

team, early in the year we held a half-day focus group/workshop. Whereas in the first year the focus group/workshop was largely devoted to listening to the educators' reflections on their students' learning and their own learning and teaching, in the second year we introduced technical guides, tip sheets, and teaching ideas for both indoor and outdoor learning experiences. In addition, we challenged the educators to work in teams to use a variety of tools within the apps to create their own slideshows.

At this stage in the project, the children were broadening and deepening their use of the iPad apps. The following slide is an example of this more extended exploration. This visual is a slide Elia (age 5) made by choosing a space background, and then adding her own planets and spaceship. As she dramatically describes her creation in her voiceover narration, she becomes enthralled in her own story:



Figure 5 Student's work by Elia

[MPEG4 file submitted separately]

The educators had asked for more teaching strategies (instructional competence) at the end of the first year, but in order to facilitate more complex use of the apps, they needed to circle back and deepen their technical knowledge (operational competence). This, in turn, led to a more

sophisticated understanding of how the apps could support student learning (curricular competence). To a lesser degree, they also modified their routines around turn-taking and the time they made the iPads available (functional competence) in response to the students' increased comfort with the iPads.

A number of factors led to the second year of the project beginning more smoothly than the previous year. First, educators had a year of experience under their belts. Second, half of their students were returning for the second year of the two-year kindergarten program and could act as peer mentors to the new children. Finally, the focus group/workshop experience, including the technical and pedagogical resources they had requested, gave the educators new ideas and renewed enthusiasm for using DT in their programs.

Cruising Along

The second year continued to progress smoothly, with only a few minor challenges occasionally surfacing. When these obstacles did arise, it seemed the educators, children, and researchers experienced less anxiety. Their previous experience led them to be more open to experimenting with a range of strategies, both pedagogical and technological. The educators, children, and researchers were benefiting from renewed confidence and comfort in their roles.

Many of the behavioural challenges observed earlier in the project lessened in the second year. With increased integration into the daily routines of the classroom, the children's worry over getting a turn with the iPads reduced. Children appeared to view the iPads as another learning material. Sharing and turn-taking happened in more child-directed ways, with some children establishing and managing their own time-keeping systems and sign-up sheets. While some classrooms were still following the previously adult-determined methods for turn-taking, the use of timers and need for educators to police the equitable sharing of the iPads no longer

appeared to be a concern. Having time to become comfortable with the apps' various tools, coupled with the educators' deeper understanding of the curricular possibilities of this DT, contributed to the children producing more interesting and complex work.

Many children had become comfortable with the basic features of the app and had moved beyond drawing simple pictures and taking photographs with the app. They were now producing drawings, videos, photographs and audio recordings that included many forms of oral, visual, and print literacy. Some of these were represented by narratives the children had created, such as detailed documentation of classroom experiences (e.g., a series of photos documenting melting snow that had been brought in from the playground, and carefully choreographed and rehearsed dance videos) and short stop-motion animation videos. The two slideshows below illustrate the development of one child from the first year of the project to the second. In the first year, Omar (aged 4) created a simple drawing on one slide depicted below:

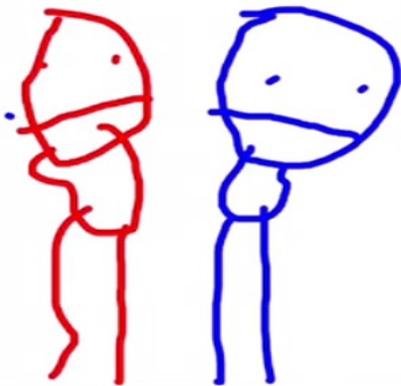


Figure 6 Student's work by Omar

In the second year, he continued to explore drawing human figures, but produced seven separate slides that when played together as a slideshow became a stop-motion animation video of two figures playing ball, depicted below:



Figure 7 Student's work by Omar in the second year

[MPEG4 file submitted separately]

The researchers and educators had not realized that a stop-motion video could be produced this way, and had certainly not taught the children how to do so. By the middle of the second year Omar, and many other children, were planning and producing digital creations that went far beyond what was expected. This progress was recognized and appreciated by the educators, as one said: "Seeing their growth from that free exploration to making the videos, taking the pictures, documenting and even interviewing the other kids. It has been such a growth with leaps and bounds." (Educator, Year 2)

Furthermore, children who were now in the second year of the project were able to support their younger peers who had just joined the class and who less experience using the app. This not only helped to alleviate some of the challenges related to one-on-one adult support, but also provided valuable peer teaching opportunities for the older children. As one educator stated:

They work in group sometimes, so the [older children] take the leadership to teach the [younger children] what they can do – instead of us. And I think getting that information from their peers is way more authentic than when they get it from us. (Educator, Year 2)

Of course individual children and educators were at different levels of interest and skill with respect to DT in the kindergarten programs. However, the open-ended nature of the apps supported the children, and the emergent design of the research project supported the educators in ways that were flexible and responsive to their needs. This had proved useful in meeting the operational and functional competencies that had been primary concerns in the first year, and also in supporting curricular and instructional competencies as the project progressed. Interviews at the end of the second year provided an opportunity for reflection. One educator expressed it this way:

I will be very honest. In the beginning... I would have never given the iPads to the kids if this project was not there. I would have been so hesitant and apprehensive. What if they press the wrong button? I think the support from [research assistants] made me feel like, ‘okay whatever happens they will be able to fix it’ ... It was a learning curve for us as well. So now, I mean we are very comfortable using them. (Educator, Year Two).

The educators and researchers had become stronger in all four of the competencies and were once again experiencing high levels of self-efficacy. As a result, they were able to more clearly see the value of using these open-ended apps to support young children’s literacy learning in their classrooms (curricular competency). However, at the end of the second year interviews, they were asking for another focus group/workshop with more in-depth technical guidance and more curriculum ideas and teaching strategies. Once again, a greater appreciation for the

curricular and instructional competencies required to more fully and meaningfully integrate DT into their programs was leading them back to a desire strengthen their operational competency (Blum et al., 2009).

5. Discussion

The first two years of this study revealed the complexity of DT integration into kindergarten classrooms on many levels: technical; structural; social; and pedagogical. In keeping with results from recent research (e.g., Blackwell, Lauricella & Wartella, 2014; Parette, Quesenberry & Blum, 2010; Ertmer & Ottenbreit-Leftwich, 2013) it was neither quick nor easy to navigate teaching and learning with DT for the children, educators, or the researchers. Rather than moving through a series of steps to a predetermined goal, the amount and complexity of DT use was influenced by many contextual factors, and was enabled by the longitudinal nature of the study, as found in earlier studies (e.g., Chen & Chang, 2006; Fisher, Frey & Nelson, 2012).

The four competencies in the model proposed by Blum, Parette, and Watts (2009) were clearly in evidence during the two-year period of DT integration, but the educators' movement through the competencies was neither linear nor sequential. Early in the project, the focus was on operational competency, ascertaining how this technology worked with functional competency, determining ways to store, charge, and manage the iPads within the classroom. At this early stage, a basic understanding of the literacy learning potential (curricular competency) and basic teaching strategies (instructional competency) were sufficient. As the educators and children became more proficient with the technology and the management of the technology over time, the educators witnessed the extent of the literacy learning potential of the open-ended apps. They expressed a desire to circle back to increase their operational competence (how the technology

works) and instructional competence (teaching strategies) so that they could better support the curricular potential that they were seeing. This movement back and forth between the competencies happened multiple times and at different rates for different educators. This spiral rather than linear movement through the competencies was possible because of the responsive nature of the research project. Through observation, interviews, questionnaires, and focus group/workshops, the educators experienced opportunities to explore their students' work and their own teaching, and make plans based on those understandings. The research team was able to gain insight into the educators' thinking and respond accordingly.

The study also revealed the importance of a respectful and responsive approach to teacher learning in DT. This study did not incorporate a developmental, skill-based model of professional development, but one that sought to be responsive to the context and needs of the educators and children (Laffey, 2004). The educators needed time and many kinds of support to purposefully integrate the open-ended apps into their classrooms and their pedagogy. The educators, in turn, gave the students time, resources, and support as needed. This responsive approach on the part of the research team and the educators led to far more widespread and innovative use of the DT by the children than was originally expected.

This research represents a response to Pacini-Ketchebaw et al.'s (2015) call to challenge the assumptions of traditional professional development. As noted above, the professional development model in this research project was not linear or sequential (Pacini-Ketchebaw et al., 2015, p. 67). The challenges and new learning ebbed and flowed in response to technical issues, the time of year, and the interests of the children and educators. The goal of the research project was to respond to the educators' understandings and needs as they integrated the open-ended apps into their kindergarten literacy programs. The educators themselves were not considered to

be stable, unchanging subjects (Pacini-Ketchebaw et al., 2015, p. 67), but as knowledgeable and resourceful educators seeking to understand their students and improve their practice. They had a great deal of autonomy and agency in how they participated in the project. They chose when, how, and where to use the iPad apps in their programs. The project provided a loose structure by providing the iPads and apps, bi-weekly visits, and annual focus group/workshops and interviews, but within that structure, the educators used their professional judgement to guide their practice.

Finally, change in the research project was complex and context-specific did not occur in isolated or pre-planned increments. Each of the 14 classrooms developed their own routines and preferred ways of using the apps, and children within each classroom engaged with the apps in response to their particular contexts. Children influenced and inspired each other, and through the focus group/workshops, educators learned from and with each other.

6. Future Directions

The findings from this study demonstrate the power of a responsive, open, and longitudinal approach to teacher learning. In effectively integrate DT into learning for young children, learning, educators need responsive professional learning opportunities that are accepting of their varied levels of digital experience, interest, confidence, and competence. Responsive professional learning needs to be respectful of educators' emotional, technical, and pedagogical needs, and be flexible as those needs change over time and in different contexts. Furthermore, educators need to be able to exercise their professional judgement during their involvement in any professional learning program. Professional learning providers need to be empathetic and non-judgmental as they support educators who are navigating the integration of DT into their programs.

An important aspect of a responsive approach to professional learning is being open to changing roles and outcomes (see Mobile devices for preschool-aged children). Professional learning providers need to be ready to shift from technical trainers, to observers, to coaches, to resource providers as requested by educators. Educators, in turn, need to be open to their students' changing needs and interests with respect to DT. When educators, and students, experience freedom and support to explore DT at their own pace and in their own ways, there is a greater possibility of increased creativity, innovation, and confidence in teaching and learning.

Providing a responsive and open approach to professional learning in DT takes time. A longitudinal approach to professional learning in DT, as in this study, provides the time to develop relationships between researchers and educators, and for all parties to navigate the inevitable ebbs and flows of DT learning in a classroom environment. When educators or children encounter challenges, there is time to problem solve and change direction as needed. Furthermore, a responsive, emergent, and longitudinal approach to professional learning supports educators and children to go beyond basic proficiency to explore a variety of DT teaching and learning applications that are meaningful in their particular contexts.

Cross References

Mobile devices for preschool-aged children

1:1 iPads in 1st Grade: Case Study of a Teacher's Concerns and Implementation

Teachers in control: customizing mobile resources for language learning

Learning to Teach with Mobile Technologies: Pedagogical Implications In and Outside the Classroom

Gatekeepers to Millennial Careers; Teachers Who Adopt Technology in Education

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