Mobile Learning in Pre-Kindergarten: Using Student Feedback to Inform Practice

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ABSTRACT

There is a trend to use mobile devices in K-12 classrooms and create 1:1 learning experiences. Current research has focused on creating student collaborative efforts and increasing engagement when learning using the iPad, as well as the user-friendly characteristics and the tremendous number of apps available. There continues to be a need for empirical evidence supporting the effectiveness of mobile devices on student achievement. The purpose of this study was to determine how integrating mobile devices into a Pre-Kindergarten curriculum using informal feedback from students affects students' academic achievement. The study employed a two-group, quasi-experimental design consisting of 28 students from two Pre-K classrooms. The experimental group utilized iPads with guided instruction, coupled with informal feedback from students, to target emergent literacy and early math skills; the control group did not have access to iPads. All students were given the Florida VPK Assessment at the beginning and end of the study. Results of the ANCOVA revealed significantly higher Phonological Awareness and Mathematics measures for the iPad class, suggesting that integrating mobile learning in content-specific areas using informal student feedback effectively increases early childhood education students' academic achievement. Best practices for integrating mobile learning to enhance student engagement are discussed.

Keywords

Mobile learning, Tablets, Early childhood education, Formative assessment, Informal feedback

Introduction

In the pervasiveness of today's digital society, mobile devices are changing the face of education. Although the Apple iPad was originally envisioned as a single user device, school districts and universities across the country are purchasing tablets and other mobile devices in massive quantities for innovative use in classrooms (Lawrence, 2012; Price, Jewitt, & Crescenzi, 2015; Tate, 2012). There is a great deal of anecdotal evidence (i.e., success stories) on the effectiveness of mobile devices in the classroom (Clarke & Abbott, 2013; Lenovo Education, 2012b; Mahaley, 2013; Morelock, 2011) and best practices for getting started (Victoria Department of Education and Early Childhood Development, 2011; Lenovo Education, 2012a; Mahaley, 2013); and in the last few years there are more researchers examining the effectiveness of mobile devices on student achievement (Chou, Block, & Jesness, 2012; Kucirkova, Messer, Sheehy, & Fernández Panadero, 2014; Ross, Morrison, & Lowther, 2010). The prevailing scholarly literature on mobile learning reflects positive correlations between student engagement and effective use of technology (Chen, Lambert, & Guidry, 2010; Falloon & Khoo, 2014; Laird & Kuh, 2005), perceived engagement and perceived learning while using iPads (Diemer, Fernandez, & Streepey, 2012), and comfort levels and prolonged use of the iPad (Diemer et al., 2012).

While many of these studies were conducted in higher education institutions, there continues to be the need to focus on research in K-12 schools, especially in the early childhood education setting. Many of the previous studies have focused on user-friendly interface, mobility, touchscreen, and connectivity to a world of resources and apps (Price et al., 2015). Falloon (2013) conducted a study in New Zealand with 18 five-year-olds to investigate if using iPads with students could support learning. Falloon (2013) concluded all apps used for instruction should be evaluated for design and content prior to implementation in the classroom. Falloon (2013) also found that the disruption of an innovation and novelty of the devices could be used to motivate students and create engagement for innovative learning opportunities. Finally, Falloon (2013) alluded to the importance of incorporating formative and corrective feedback with students in the learning process.

Other researchers have focused on mobile devices to create student collaborative efforts and increase engagement when learning using the iPad. Kucirkova et al. (2014) examined the effects of a story-making app using 41 four- and five-year-old students from Madrid, Spain. Supported by previous research, Kucirkova et al. (2014) found that specific app features and content could influence the degree to which children's engagement in the learning task was of "educational value" (p. 176). This research supported the notion that the iPad is a game

changer in education and that we need to find more ways to harness it as a powerful teaching and learning tool. Hwang and Chang (2011) conducted a study in Taiwan using formative assessment to determine if students' attitudes and achievement could be affected when using mobile devices. They found that utilizing a mobile learning approach could improve students' attitudes and achievement.

Due to the many promising learning opportunities, there continues to be a need for empirical evidence supporting the effectiveness of these devices on specific areas of student achievement. Therefore, the purpose of this study was to determine how integrating mobile devices into a Pre-Kindergarten curriculum using informal feedback from students affects Pre-K students' academic achievement (i.e., Print Knowledge, Phonological Awareness, Mathematics, Oral Language/Vocabulary) at a rural, public charter school in the southeast.

Mobile devices, which include tablets, smartphones, PDAs, e-readers, and MP3 players, can be used to customize student learning and address education inequality when integrated into the classroom by innovatively informing policy and practice. Schrum and Glassett (2009) advocated that information and communication technologies could play a crucial role in empowering students to demonstrate authentic, meaningful learning. According to Chou et al. (2012), "with sound pedagogy and implementation, one-to-one learning has the potential to transform the classroom into a true learner-centered environment in which communication, collaboration, and creative problem solving flourish to create student-driven learning" (p. 13). Mobile technologies also are being used to address education inequality through various policies and practices throughout the United States. Many districts are attempting to close the achievement gap by giving students with limited social and economic resources access to mobile devices for use at school and home. Miami-Dade County Public Schools (M-DCPS, 2013), the fourth largest school district in the US, which consists of students from 160 countries, speaking 56 different languages, and 74% of the students being eligible for free and reduced lunch, approved a policy which ensured that every student had a digital device by 2015 (Smiley, 2013). According to Sung, Chang, and Liu (2016) teaching and learning with mobile devices is innovative and unique: they encourage anywhere, anytime learning; reach underserved children; develop 21st century social interactions; adapt to various learning environments; and enable a personalized learning experience.

Although little research exists on using informal feedback from elementary students to inform practice, Stiggins (2006) makes the distinction between *assessment of learning* (i.e., summative assessment) and assessment *for* learning (i.e., formative assessment). Stiggins argues that ongoing, informal feedback from students (i.e., formative assessment) improves students' understanding of fundamental skills. Similarly, Andrade, Hefferen, and Palma (2014) found utilizing informal feedback among art teachers and students enhanced engagement and the quality of students' work. In other words, informal feedback can be used to promote learning. The present study sought to determine how the integration of mobile devices in a Pre-K classroom, with the use of formative assessment, could enhance current instructional practices and create new opportunities for learning.

Theoretical framework

This study is grounded in the Theory of Mobile Learning (TML), which is based on constructivism and posits that learning is continuous and extends outside the classroom (Sharples, Arnedillo-Sánchez, Milrad, & Vavoula, 2009). Mobile devices enable 21st century students to construct their knowledge anywhere and anytime. According to Zimmerman and Howard (2013), "mobile devices can situate and connect learners by supporting authentic, context-specific, immediate learning" (p. 2). Thus, when students learn foundational literacy skills and basic mathematical concepts using mobile devices at an early age their learning takes on an entirely new perspective. Learning is no longer confined to the classroom; integrating mobile technology enables educators to customize student learning by creating authentic and appealing learning activities to engage students anytime and anyplace (Hess & Gunter, 2013).

Utilizing the Florida VPK assessment areas (i.e., Print Knowledge, Phonological Awareness, Mathematics, Oral Language/Vocabulary), which are aligned with the Florida Early Learning and Developmental Standards for Four-Year Olds (Florida Department of Education [FLDOE], 2013a), the following research questions guided this study: (a) How does mobile learning using informal feedback from students to inform practice increase Pre-K students' Print Knowledge? (b) How does mobile learning using informal feedback from students to inform practice increase Pre-K students' Phonological Awareness? (c) How does mobile learning using informal feedback from students to inform practice increase Pre-K students' Mathematics skills? (d) How does mobile learning using informal feedback from students to inform practice increase Pre-K students' Oral Language/Vocabulary skills?

The corresponding directional alternate hypotheses were (a) integration of mobile technology using informal feedback from students to inform practice will increase Pre-K students' Print Knowledge, (b) integration of mobile technology using informal feedback from students to inform practice will increase Pre-K students' Phonological Awareness, (c) integration of mobile technology using informal feedback from students to inform practice will increase Pre-K students' Mathematics skills, and (d) integration of mobile technology using informal feedback from students to inform practice will increase Pre-K students' Oral Language/Vocabulary skills.

Methods

Participants

Participants for the study consisted of 28 Voluntary Prekindergarten (VPK) students at a rural, public charter school in Florida. All children who reside in Florida and turn 4 by September 1st are eligible for Florida's free VPK education program (Early Learning Coalition of Miami-Dade/Monroe, 2014). Participants were students from two Pre-K classrooms at the rural, public charter school. All participants were between the ages of 4 and 5; the majority of participants were Caucasian and from low to middle income families. Participant selection was based on cluster sampling using intact classrooms. The first classroom (n = 20) utilized iPads to practice their emergent literacy and early math skills. The second classroom (n = 8) did not have access to iPads in the classroom to practice skills.

Instrument

The Florida Center for Reading Research, in collaboration with the FLDOE, developed the Florida VPK Assessment in early 2012 to provide teachers with valid and reliable feedback regarding a child's progress (FLDOE, 2013b). Based on the *Florida Early Learning and Developmental Standards for Four-Year-Olds* (FLDOE, Office of Early Learning, 2011), the VPK Assessment was created for teachers to guide instructional decisions in the Pre-K classroom based on progress monitoring. Although there are three assessment periods (Assessment Period 1 [AP1] given in September**,** Assessment Period 2 [AP2] given in January, and Assessment Period 3 [AP3] given at the end of May), only AP1 and AP3 are required. Therefore, for this study only AP1 and AP3 were analyzed.

The VPK Assessment includes progress monitoring measures in four areas aligned with the *Florida Early Learning and Developmental Standards for Four-Year Olds*: (a) Print Knowledge (12 assessment items and 2 practice items), which assesses the child's ability to recognize letters, name letters, and identify letter sounds; (b) Phonological Awareness (14 assessment items and 2 practice items), which assesses the child's ability to combine smaller sounds or syllables to form a word, blend compound words, and recognize a word when part of it is taken away; (c) Mathematics (13 assessment items), which assesses counting skills, numerical associations, and math reasoning skills; and (d) Oral Language/Vocabulary (22 items for AP1 and 23 items for AP2 and AP3), which assesses a child's expressive and receptive language, and targets the child's knowledge of the parts of speech (FLDOE, 2013a). The content for the Florida VPK Assessment was developed by identifying the best predictors of later reading success (i.e., print awareness, phonological awareness, and oral language/ vocabulary skills) and the best predictors of mathematics success (i.e., number sense; FLDOE, 2013a).

Data collection

The present study utilized a quasi-experimental design. Participants consisted of 28 students at a rural, public charter school in Florida. Participants were students from two PreK classrooms. All students were given the VPK Assessment (AP1) in September 2012. Upon IRB approval, beginning in October 2012, the experimental group (n = 20) practiced emergent literacy and early math skills utilizing iPads 2 days a week for approximately 15 minutes of guided instruction by one of the researchers, with the assistance of the VPK teacher. Over the course of the school year the following types of Applications (apps) were used with the experimental group: (a) Multi skill apps (e.g., phonics, counting, and matching), (b) Counting apps, (c) Early Math skill apps, (d) ABC apps, (e) Phonics apps, (f) Rhyming apps, (g) Matching Letters/Spelling apps, (h) Sight Word apps, (i) Tracing apps, (j) Science apps, and (k) Sorting/speed skill apps. With the unique diversity of mobile learning, the researchers and VPK teacher could choose basic Pre-K apps based on student skill levels to enhance each child's individual abilities and needs. Informal feedback was collected from the students for each mobile app used. If students were

highly engaged in the app (i.e., on task for the entire time, eager to "play" on the iPads the next day, self-selecting the app when given a choice), the app was appropriate (i.e., no rude sounds for incorrect answers to disrupt the classroom, students were appropriately challenged), and it appeared to increase their knowledge on the subject area (i.e., students thought through the problem and chose the correct answer rather than simply going through the motions with little thought), then the app was approved and saved on the classroom iPads. Apps that did not meet the aforementioned criteria were deleted from the classroom iPads.

The experimental group continued to receive guided instruction using mobile devices until the end of the school year (i.e., for a total of 7 months). The control group (n = 8) did not have access to iPads in the classroom to practice skills; these students were taught with the traditional Pre-K curriculum. At the end of May, students in both the control and experimental groups were administered the Florida VPK Assessment (AP3).

Data analysis

Quinn and Keogh (2002) recommend using Type III sum of squares (SS) for unbalanced designs (i.e., those with unequal sample sizes). In SPSS, Type III sum of squares is the default method for unbalanced models with no empty cells (i.e., SPSS automatically accounts for the differences in the sum of squares by using Type III sum of squares so long as there is at least one observation per cell) and is equivalent to Yates' weighted-squares-of-means technique (IBM, 2011). Although unequal sample sizes can be problematic, instead of randomly removing observations to equate samples, which could reduce power, Quinn and Keogh (2002) suggest ensuring the assumptions of the statistical analyses are met to minimize confounding issues. Although ANOVA is considered robust to moderate departures from the homogeneity assumption, when the sample sizes are very different, the departure needs to be minimal (Sweet & Grace-Martin, 2012).

In order to determine whether integrating mobile technology into the Pre-K curriculum using informal feedback from students' enhanced emergent literacy and early math skills, an Analysis of Covariance (ANCOVA) was conducted using AP1 (i.e., the pretest) as the covariate. Prior to the analysis, viewing a normal Quantile-Quantile (Q-Q) probability plot, which plots the observed values to the expected normal values, assessed the assumption of normality. When the normality assumption is met, the observed values and the expected normal values approach a straight line. The Q-Q plots for all Florida VPK assessment measures (i.e., Print Knowledge, Phonological Awareness, Mathematics, and Oral Language) showed little deviation from the line, suggesting the normality assumption was met for all measures. In addition, the Levene's test for equality of error variances was met for all variables and Tukey's Least Significant Difference (LSD) was used to control the familywise error rate.

Results

To ensure the experimental and control groups were similar at the outset, independent samples t tests were conducted for each of the AP1 measures. Results revealed no significant differences between the experimental and control groups in any of the AP1 measures (see Table 1) ensuring that both the experimental group and the control group were similar at the beginning of the year.

Table 1. Mean Florida VPK Assessment scores during AP1

Measure	Group	*M*	*SE*	*p*
Print Knowledge	iPad	8.30	.65	
	Control	6.86	1.42	.30
Phonological Awareness	iPad	6.65	.64	
	Control	5.71	1.64	.52
Math	iPad	9.50	.82	
	Control	7.89	2.25	.39
Oral Language	iPad	16.60	.80	
	Control	15.71	1.77	.61

Note. VPK = Voluntary Prekindergarten ; AP1 = Assessment Period 1.

Results of the ANCOVA revealed a significant testing effect, Wilks' λ = .26, F (4, 22) = 15.60, p < .001, η^2 = .74, β = 1.00; see Table 2). Not surprisingly, both experimental and control groups performed significantly better on all AP3 measures compared to AP1 measures.

Results of the ANCOVA also revealed a significant testing by class effect, Wilks' $\lambda = .52$, F (4, 22) = 5.00, $p = .005$, $\eta^2 = .48$, $\beta = .91$ (see Table 3). Students in the experimental group had significantly higher Phonological Awareness and Mathematics measures during AP3 compared to the control group; consequently the null hypotheses for Phonological Awareness and Mathematics were rejected. Even though the experimental group outperformed the control group during AP3 for Print Knowledge and Oral Language, the results were not significant. Consequently, the researchers failed to reject the null hypotheses for Print Knowledge and Oral Language.

Table 2. Mean Florida VPK Assessment scores

Measure	Testing	*M*	*SE*	*p*
Print Knowledge	AP1	7.60	.69	
	AP3	11.05	.37	.00*
Phonological Awareness	AP1	6.18	.72	
	AP3	9.18	.65	.00*
Math	AP1	8.68	.69	
	AP3	12.9	.95	.00*
Oral Language	AP1	16.16	.85	
	AP3	18.95	.59	.00*

Note. AP1 = Assessment Period 1 (i.e., pretest); AP3 = Assessment Period 3 (i.e., posttest). $^*p < .05$.

Table 3. Mean Florida VPK Assessment scores during AP3

Measure	Group	*M*	*SE*	*p*
Print Knowledge	iPad	11.25	.38	
	Control	10.86	.64	.17
Phonological Awareness	iPad	11.50	.67	
	Control	6.86	1.13	.02*
Math	iPad	14.70	.59	
	Control	11.14	.97	.04*
Oral Language	iPad	20.05	.61	
	Control	17.87	1.03	.12

Note. $^*p < .05$.

Discussion

According to research conducted by the FLDOE (2013a), students can benefit from targeted instruction in the four skill areas assessed in the study (i.e., Print Knowledge, Phonological Awareness, Mathematics, and Oral Language) during the Pre-K year. The purpose of this study was to target emergent literacy and early math skills for a group of Pre-K students using mobile technology to enhance instruction, use informal feedback from students to guide app selection, and determine how interactive mobile learning affected academic achievement, as measured by the Florida VPK Assessment. Results of the study suggested that mobile learning using informal feedback from students to guide instruction significantly increased students' Phonological Awareness and Mathematics skills compared to a control group that did not receive targeted instruction using mobile technology. Since many of the iPad apps used with the experimental group specifically focused on phonics (i.e., phonological awareness) and counting, sequencing, or early addition (i.e., mathematics), this result was anticipated. These findings are consistent with many of the informal success stories on mobile learning (e.g., Clark & Abbott, 2013; Lenovo Education, 2012b; Mahaley, 2013; Morelock, 2011), and add to the literature by providing empirical evidence on the power of innovative teaching practices, student-centered formative assessments, and interactive instructional strategies.

Mobile learning using informal feedback from students had no significant effect on students' Print Knowledge, which was inconsistent with the study's hypotheses. Since print knowledge is a basic Pre-K skill that all students must master, this result was not surprising. In addition, at the beginning of the study the teacher of the control group classroom asked if she could use the Starfall Education Website, which specifically focuses on print knowledge, on the classroom desktop computer with her students. Since this was one of her standard instructional strategies, the researchers allowed it since they did not want to hinder the development of the control group. Therefore, focused attention on print knowledge by the control group, regardless of medium, could have minimized the differences between the groups. It is also important to note that Starfall was one of the iPad apps used with the experimental group that was used regularly based on positive, informal feedback from students. Given both the experimental and control groups improved their print knowledge significantly, it

appears print knowledge-specific iPad apps and the Starfall Education Website are both effective at enhancing Pre-K students' print knowledge. Finally, mobile learning using informal feedback from students had no significant effect on students' Oral Language/Vocabulary skills. Since the research did not specifically use apps that focused on expressive and receptive language, or targeted knowledge of parts of speech, this result was also not surprising. Consequently, this confirms that only the areas targeted by the researchers were affected by the use and integration of iPads in the classroom. Given the small number of participants in the study, future research should replicate the study using larger sample sizes that are equivalent, and guided instruction focused on oral language skills to determine if mobile learning can increase achievement in this area as well.

Recommendations

Based on the findings of this study, the researchers suggest the following recommendations for future studies and educators who plan to implement mobile devices as a teaching strategy. Prior to allowing students to use the mobile devices, teachers need to plan extra time for evaluating and setting up iPads or mobile devices for an integrated lesson. Young students are quite savvy and will quickly determine how to delete apps. Restrictions on the iPad should be enabled to make sure only age-appropriate content can be accessed. The researchers recommend that educators in early childhood should turn off the ability to delete apps. According to Lacey, Gunter, and Reeves (2014), choosing appropriate apps is the first step to engaging the digital learner. Although there are many free apps out there, many of them offer in-app purchases that are distracting for young students. The researchers recommend turning off the ability to make in-app purchases in restrictions area, since the ads are very tempting to young minds. All apps should always be evaluated and tested prior to using them in the classroom. The researchers found that some of the apps that were used in this study provided inappropriate feedback and noises for incorrect answers. Other apps do not give the proper remedial assistance. Through the informal feedback process it was quickly discovered that these types of apps should not be included on the classroom iPads. When selecting educational apps the researchers suggest seeking other types of evaluation or sites such as APPitic, which is a directory of educational apps that have been tested extensively by Apple Distinguished Educators.

Once a variety of apps have been selected, the next step is to introduce them to students slowly. Starting with one app at a time, make sure to have several different levels available to appropriately differentiate instruction. When working with younger students, educators should plan to introduce apps for a short period of time (about 10-15 minutes) due to young student's shorter attention spans. Students' informal feedback can provide valuable insight in the evaluation process of the apps for instructional value. The informal feedback can be gathered overtly or covertly, depending on the age and cognitive abilities of the students. To evaluate whether the app will increase knowledge on the subject area educators must ensure that students are being challenged appropriately based on their level and the app is content-specific matched to the curriculum standards. Teachers should remove any apps from the classroom devices that do not meet the aforementioned criteria. The researchers recommend creating a list of approved apps for parents and posting on the classroom Website. Engaging parents in the process can improve achievement for all students, and for schools with BYOD initiatives, it ensures all students have the classroom-approved apps on their own devices. For mobile learning to be successful educators must provide opportunities for students to learn anytime and anywhere. Educators should consider other uses and recourses available with mobile learning, such as virtual field trips; situational learning with problem solving; interactive gamified learning; and student created projects, like digital stories and screen casting.

This study provides empirical evidence to support the integration of mobile technology in content-specific areas combined with the use of informal student feedback increases early childhood education students' academic achievement, as well as offers suggestions on how to integrate mobile learning into the classroom. With today's digital generation having access to knowledge at the tip of their fingers, anytime and anywhere, it is imperative that teachers integrate mobile learning into their teaching best practices. Additionally, in order to increase student engagement and achievement, early childhood educators should use informal feedback from students to inform classroom practice. With school districts across the country purchasing mobile devices in bundles in an attempt to close the achievement gap and engage at-risk students, educational researchers must continue to provide empirical evidence to illustrate the power of mobile learning.

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