Technology in Early Childhood Education

Mike Larson

Alternate Plan Paper, Ed Ld 694

Professor Kaufman

Spring 2016

Introduction

Technology is fast becoming ubiquitous in K-12 education. Early childhood education programs are often somewhat behind their K-12 counterparts in adoption and integration of technology into their curricula. Many programs are only beginning to formally integrate technology in their classrooms. With the advent of touch-based devices, technology use by children who are in the beginning stages of literacy is now commonplace. The purpose of this paper is to explore the current state of research dealing with technology in early childhood education. A secondary goal is to create a clear picture of what educational leaders need to consider when planning their program's technology integration.

The paper begins with an examination of how young children use technology. It then moves into an inventory of how technology is used in today's early childhood education programs. A broad examination of how technology can be integrated into a Pre-K program is followed by examples of research around specific technologies and content areas. Lastly, concerns about the topic of screen-time are explored.

Literature Review

How Children View and Use Technology

Before examining how early childhood programs can use technology effectively, some time should be spent to understand how young children use and perceive technology. A Dutch study by McKenny and Voogt (2010) took on this task. The study involved 167 children between the ages of 4 and 7. Individual interviews were conducted, examining the students' demographics, their access to technology, the activities they use computers for, their attitudes towards computers, and an assessment of their technology skills. It's important to note that the data was collected in 2007, so the subjects were unlikely to have used tablet or handheld

computers. There have been considerable changes in how society interacts with technology since 2007, which may bring the results of the study into question. Nevertheless, this study is useful because it examines the experiences of children directly, as opposed to those that examine parents' or educators' perceptions of how children use technology.

Amongst the pre-K children, 91% reported using computers outside of school. For 85% of the pre-K children, that use occurred in their home. The activity that pre-K students most frequently engaged in, both at school and out of school, was playing a game. In school, the pre-K students' second most frequent activity was drawing using the computer, while at home the second most frequent activity was using the Internet. Technology skills were assessed by asking students which activities they could do independently and which they could do with help from someone. Forty-five point five percent of pre-K students reported that they could start a computer game by themselves, and 45.5% reported that they could start a game with help. Sixty-seven point seven percent of those children could play a game by themselves, while 27.3% could play a game with help. Twenty-seven point three percent could draw on the computer without assistance, while 21.2% said they could draw with help (McKenny and Voogt, 2010).

Several conclusions can be drawn from the data. Pre-literate children (the authors state that Dutch schools begin teaching reading in first grade) do have digital literacy skills. They understand symbols and icons, even if they can't read the associated text. Using a graphic user interface, mouse, and keyboard works for them. They are able to make choices about what they are doing, and aren't just mimicking what they see older people doing. This study lends itself to the idea that technology in early childhood education can be a useful educational tool.

The Current State of Technology in Early Childhood Education

In a broad study Simon, Nemeth, and McManis (2013) surveyed many different aspects of the current state of technology in early childhood classrooms. The study provides a snapshot of what technologies are used, how often they are used, reasons for use (or non-use), types of activities and experiences, budget considerations, and the professional development that supports the technology. The survey included responses from 369 teachers and 116 administrators. The context this survey provides is meaningful in understanding some of the challenges found in successfully integrating technology into an early childhood program.

The types of devices found in classrooms were unsurprising. Nearly all respondents (95%) reported that they had a traditional desktop or laptop computer in their classroom. Almost half (44%) have an interactive whiteboard. At the time of the survey, 37% used tablet computers, such as an iPad. A much smaller number of classrooms (19%) had hand-sized devices, such as an iPod Touch or smartphone. Multi-touch tables were used by only 6% of classrooms. The authors commented that older technologies (traditional computers) are much more likely to be used in classrooms, even though tablets receive a lot of media attention (Simon, Nemeth, and McManis, 2013).

The Simon, Nemeth, and McManis (2013) conclude that support and use strategies for traditional computers still need to be included in current technology plans. Many respondents expressed concerns about mobile devices (tablets and handhelds) being a distraction in the classrooms. The authors stress that while those concerns are real, efforts must be made to explore the possibilities that smaller devices create. Increased communication with families and individual learning experiences for students are areas in which the authors feel smaller devices offer advantages.

How often technology-equipped teachers use the tools with their students was also explored. Fifty-five percent of teachers generally offered students opportunities to use technology each day, while 26% used the technology with their students three to four days per week, and 12% reported one to two days per week. Fewer than 1 in 10 use technology less than once per week. Duration of use varied by device type. Sixty-three percent of teachers use traditional computers with their students for less than 30 minutes per day, while 58% of teachers used tablet computers less than 30 minutes per day. Sixty-seven percent of teachers with interactive white boards or multi-touch tables were used for more than 30 minutes per day. Smartphones were used for less than 30 minutes by 63% of respondents (Simon, Nemeth, and McManis, 2013).

The Simon, Nemeth, and McManis (2013) conclude that tablets and traditional computers lend themselves to small-group or individual instruction. They believe that these more individualized types of instruction could lead to longer periods of use, particularly during 'choice time' for students. The larger interactive white boards require teacher-led activities, and are more often used in large-group settings. The data suggests that teachers are using technology for longer durations in teacher-led activities, and for shorter durations in child-initiated activities. The authors suggest that programs attempt to strike a balance between large group experiences, individual experiences, and concerns about extended screen time for young learners.

Simon et al. (2013) also surveyed program staff about their reasons for using and not using technology. Seventy-five percent of respondents said that they use it because children enjoy using technology, while only half (51%) said that it helps their program to meet its goals. One-quarter of educators are using technology in a way that they don't believe contributes to their program goals. Many educators reported using technology to further extend concepts and

skills (67%) and to indirectly support the introduction of concepts and skills. The authors conclude this section with the observation that leaders must be intentional and purposeful about the application of technology within their programs.

A very large number of respondents (172 out of 485) reported that they do not use technology in their early childhood education work (Simon et al., 2013). Sixty percent of those not using technology cited a lack of funding as the reason for not using technology. Thirty-five percent of respondents stated that they had concerns about technology use not being developmentally appropriate for their students, and 18% said that their program philosophy prohibited the use of technology. Clearly, there is significant resistance towards using technology in early childhood education. Interestingly, less than 5% of the educators responding stated that they felt parents were opposed to the use of technology. Conversely, 18% of educators felt that technology use was an expectation of parents.

Simon et al. (2013) conclude with a series of key findings. They observe that many more teachers are using older, more traditional technologies (desktop and laptop computers) compared to newer technologies (such as iPads and interactive white boards). How often the technology gets used varies, but most teachers use it on a daily basis. Technology isn't always used in intentional, outcome-driven ways. Many teachers use technology because the students enjoy using it, rather than to achieve a particular educational outcome. More professional development work is needed, and program administrators need to be thoughtful about how they implement and integrate technology into their scope of practice. Lastly, many early childhood programs don't yet have the resources to purposely design a technology program that fits into their budget and curriculum.

Steps to Implementing Technology in Early Childhood Education Classrooms

Lyons and Tredwell (2015) provide a clear, five-step framework for introducing technology into a classroom. The authors provided a compelling examination of reasons to integrate technology into the classroom, based on the research of others. These include that technology use leads to better language and literacy achievement (Primavera, Wiederlight, & DiGiacomo, 2001). Chiong and Shuler (2010) showed that both vocabulary and phonological awareness (linking sounds to symbols and word recognition) can be improved through the use of hand-held devices. Preschool students using tablet computers worked together and built social skills (Shifflet, Toledo, & Mattoon, 2012). Lyons' and Tredwell's (2015) five steps include: (a) assessing what students know about technology, (b) creating rules around the use of technology, (c) applying both professional judgment and program policy to technology, (d) integrating technology into a school's curriculum, and (e) making decisions based on collected data (2015). The authors hope to create a framework through which teachers can succeed in integrating technology into their classrooms. These steps are specific to the classroom, and don't include assessing which technologies to use, how to create a workable budget, or how to appropriately deliver and pace professional development. The research is very much oriented towards the classroom teacher (Lyons & Tredwell, 2015).

The first step is to assess the technology knowledge of students (Lyons & Tredwell, 2015). The idea is to determine where students are in their personal use of technology. This includes examining their vocabulary and background knowledge, determining what lessons may be required to successfully introduce technology to the students. Depending on the students, the class may already have a significant level of experience with various devices. Students should be asked where they have used technology, what their favorite pieces of technology (devices, apps, websites, etc.) are, if they like to work with others while using technology, and when they

can use technology. This provides a teacher with baseline knowledge of where their students are at, so appropriate introductory lessons can be created.

Lyons and Tredwell's (2015) second step is to create rules for the use of technology with the students. This is not about presenting the students with a list of rules, but rather working together with them to develop a set of rules that everyone can agree on. The authors believe that participatory rule-making leads to increased self-responsibility, knowledge, and self-confidence. Rules should be stated in simple, positive ways. There should be a limit of three to five rules. The authors cite Carter, Van Norman, and Tredwell's (2012) finding that students who are involved in creating their own rules better value the materials and technology used in the classroom. Examples of rules include using clean, dry hands, using soft touches, and keeping technology safe (in its protective case, for example).

Lyon and Tredwell's (2015) third step is to apply professional judgment and program policy to the use of technology. This step is broad in scope and somewhat lacking in specifics. The authors write about providing technology access to families at the school, in an attempt to ensure that all families have the opportunity to use technology together. They also suggest providing a list of community resources that provide technology access to families. Choice of applications and lessons is mentioned in this step, with the authors recommending that programs adopt software that is supported by research. Time limits are also suggested, with the authors recommending that public health guidelines be consulted when considering how much screen-time students are exposed to.

The fourth step that Lyon and Tredwell (2015) suggest deals with how to implement technology within a program's curriculum. The authors are actually using this step to select both the hardware and software that will be used, which is an area that needs to be explored in more

depth. The guidance provided is to first set early learning goals. A tech team is then created to evaluate the type of devices to be use along with the software, matching capabilities to the early learning goals. Professional development is planned to support teachers in using the technology. Lesson planning is discussed in general terms, with examples of both large and small group lessons.

Lyon and Tredwell's (2015) final step involves collecting data to be used in decision-making. Formative assessments and informal data-gathering is emphasized, for the purpose of comparing the outcomes of selected apps and lessons to progress towards stated goals. Changes are then made to better refine the process of selecting apps and lessons. The authors suggest that one basis for software selection is that apps have a progress-monitoring component, so that teachers can more easily evaluate the way students are moving towards program goals.

Lyon and Tredwell have provided a framework through which instructional technology can be purposefully integrated into the classroom. Their approach is more specific than program-wide planning, yet not descriptive of how an educator actually builds digital technology into a lesson plan. Hutchinson and Woodward (2014) provide a more lesson-specific approach to technology integration. Their work centers on literacy and language arts instruction for older students. The methodology from their work can be adapted to early childhood education, and is a good decision making process for teachers to use on a frequent basis.

Hutchinson and Woodward (2014) identify the problem of lessons using technology going off-track, with results that make educators less likely to use technology in the future. They identified a seven-step planning cycle that can help create successful lessons incorporating technology. Importantly, their planning cycle also helps teachers to recognize when technology is not the right tool for a lesson. This should result in increased confidence for instructors, more

effective application of technology resources in classrooms, and better learning outcomes for students.

Hutchinson and Woodward's (2014) first step is to identify a clear instructional goal. The goal should be clearly stated and tied to specific educational standards. The second step is to determine an appropriate instructional approach. The instructional approach includes the form of instruction, how students will learn, and what prior knowledge students will need to be successful. The third step is to select the appropriate tools for instruction, whether they are digital or not. This third step is a potential exit point for the planning cycle—if digital tools aren't the appropriate tools for the lesson, there's no need to continue to the fourth step. Tool selection includes hardware, software, and content. The fourth step is to examine how the selected tool contributes to achieving the instructional goal. This is an opportunity to examine the tool's capabilities, and to see how those capabilities can be leveraged to reach the goal and its associated educational standards. The fifth step is to examine the limitations of the tool, and to decide if they can be overcome. These constraints include the abilities of the students to successfully use the tool to meet the goal. If the constraints cannot be overcome, this is another exit point for the planning process. The sixth goal is to understand the best way to deliver the instruction. This includes thinking about the physical environment, class management, and time limits. The last step is to reflect on the instruction after the lesson has been used. Examining whether the goals were met, how the process could be improved, and looking for unanticipated opportunities can all help to refine the process for future lessons.

Hutchinson and Woodward's (2014) process is often the missing piece in early childhood technology integration. A disciplined, purposeful approach to lesson design will lead to better outcomes for teachers and students. Teachers will have more success and less frustration.

Students will use technology in ways that move them towards meeting and exceeding educational standards. Administrators should carefully consider devoting professional development time towards this approach.

Examples of Integrating Technology into Curricula

Interactive white boards (IWB) are one of the common early childhood technology tools. An IWB is a large, wall-mounted panel that has touch-screen capabilities integrated into it. A projector displays video from a computer on the IWB, and the teacher and students are able to interact with the computer through the IWB. IWBs are expensive and require significant professional development work for staff members to master the technology. While popular in early childhood settings, relatively little research as been done on their effectiveness in that setting.

Linder (2012) explores the topic of teaching mathematics with an IWB. Linder's work stretches across pre-K to 3rd grade. It begins with a discussion of the essential characteristics that early childhood math lessons should contain. Linder's five characteristics begin with building communities and communication. She stresses that children should work collaboratively, with discussions structured so that the children are involved with each other during the lesson. This creates ownership and engagement. The second characteristic is making connections between math and the real world. Linder says that this creates an understanding of why math is important, and suggests that these connections can be made outside of the traditional lesson settings, such as during snack time or free play. The third characteristic is to provide students with multiple ways to represent their understanding and thinking. This helps the students to turn concrete understandings into abstract understandings. The fourth characteristic is to use manipulatives, such as blocks or tools. This gives students the chance to physically demonstrate their learning

and understanding. The last characteristic is that math lessons should include child-centered tasks. There should be more than one way to solve a problem, and teachers should avoid telling students how the teacher would solve the problem. Giving the students time to explore the problem provides the teacher with opportunities to ask questions about their thinking and adjust the lesson to student needs.

Linder (2012) stresses that the IWB should not be the only tool used while teaching math. She says that using the IWB before or after a small-group task where manipulatives can be used. The IWB can be used to introduce the concept, encourage discussion, or demonstrate a real-world example of the concept being taught. An example of a pre-K counting lesson using an IWB is provided. It involves counting elephants that are displayed in different sizes and colors. Students discuss how the elephants are different, how many big vs small elephants there are (including how to tell a big elephant from a small elephant), and how many total elephants there are. Children are encouraged to count on their fingers during the lesson. The students take turns using the IWB to drag the elephants into groups based on the elephants' characteristics, and then count the number of elephants in each group. After each student uses the IWB, students draw the elephants on paper and count them. This lesson provides opportunities to include most of the essential characteristics of a pre-K math lesson.

Linder (2012) also discusses combining other technologies with IWBs for math lessons. Virtual manipulatives are pictures or icons that can be incorporated into IWB lessons. Virtual manipulatives are easy to find on the Internet, and can take the place of physical manipulatives. Linder suggests using virtual manipulatives in a variety of settings, including teaching patterns, counting, and sorting. Webquests—Internet-based lessons that present a particular problem to be solved—can be used to make connections in a mathematics lesson. IWBs allow students to more

easily manipulate the website lessons in a large-group format. Sites such as Starfall.com are examples of this. Linder also recommends that a video or voice recorder be used to record lessons. This can be used later to help students return to the concepts that had been taught, with the idea that reflection is an important part of learning mathematics.

Linder (2012) concludes that IWBs are an important tool in effectively teaching mathematics to early childhood students. She cautions that teachers should not be using the IWB themselves much during the lesson. Teachers should make IWB use part of the lesson, but not the entire lesson. Linder believes that IWBs can be used to make math lessons more interesting and effective for young children.

Tablet computers, such as iPads, have become common in educational settings. Flewitt, Messer, and Kucirkova (2015) look at iPads within an early learning literacy setting. The authors provided iPads to three different educational settings: 3-4 year olds, 4-5 year olds, and 7-13 year olds. We'll examine their use with the two younger groups. The authors begin their report with a discussion about the challenges educators face in integrating new technologies into their classrooms. Constraining factors mentioned include a paper-based curriculum, lack of time to examine digital resources and apps, a lack of guidance on how to integrate new technologies, and staff members having a lack of confidence in the use of the new technologies. The goal of their study was to examine what was possible when iPads and a selection of apps were integrated into early literacy classrooms.

The methodology Flewitt, Messer, and Kucirkova (2015) used in their study was quite thorough. Two classrooms were selected. The 3-4 year old classroom had no technology in use, while the 4-5 year old classroom had IWBs. An iPad was provided to each classroom for two months. The small number of iPads involved and the limited duration of the study are

unfortunate. Each iPad was equipped with a story-creation app, and instructors were encouraged to explore other apps as well. Training was provided to each instructor. Surveys, observations, and conversation were used to evaluate the iPads' effectiveness.

Flewitt, Messer, and Kucirkova (2015) identified two categories that most apps fall into. The first is a "closed" app, where users are not allowed to be very creative. Apps teaching alphabetics or numbers through the use of drills in the form of games are considered examples of closed apps. Closed apps are appropriate for introducing material or assisting with mastery, but are considered to use "outmoded behaviourist and/or transmission theories of learning" (2015, p. 297). "Open" apps are those that encourage creative activities, where the user engages in creating their own content or stories. The authors feel that open apps allow for greater development of digital literacy skills while also encouraging greater motivation and imagination for the users.

Increased motivation and involvement were found amongst students using the iPads. The ability to undo actions and carefully consider next steps was noted, particularly within art apps. The immediacy and responsiveness of the feedback from the iPads was listed as a motivator. Students who were not easily engaged with traditional writing work responded well to using iPads to tell stories. The teachers felt that the iPads better motivated students to learn (Flewitt, Messer, and Kucirkova, 2015).

The iPads also encouraged independent use and learning. Students were able to easily learn to use the iPads independently. The touch screen interface was considered to be much easier for children to use than a computer keyboard. The small size of the iPads contributed to students moving them around the room. Compared to IWBs, the iPads offered considerably

more opportunities for students to use technology independently (Flewitt, Messer, and Kucirkova, 2015).

Increased collaboration and concentration were also noted. Students wrote stories on the iPads, filmed the stories as plays using the video camera, and then shared their creations. Staff felt that students would not have done the work to write the stories if they hadn't been allowed to use the video cameras to capture their work. Students were observed helping each other to use the iPads, which the staff viewed as enhancing communication and language skills. English as a Second Language students became more engaged and were more communicative, as were shy students (Flewitt, Messer, and Kucirkova, 2015).

Challenges noted by Flewitt, Messer, and Kucirkova (2015) included the many hours staff devoted after class to both learning and exploring new apps and ideas. Much time was required to plan effective lessons. Technical difficulties sometimes interrupted lessons. At times children were frustrated when they did not understand how to complete activities or progress within apps. Younger children appeared more susceptible to frustration than older children. Classroom management became an issue when students would disagree over who's turn it was to use the iPad.

Flewitt, Messer, and Kucirkova (2015) noted that after the study was concluded, the older classroom was equipped with iPads by the school. The younger classroom had a change in staff, and the new staff were not as enthusiastic about iPads. That classroom declined to accept iPads on a permanent basis. The authors note that this shows how much influence staff members have on children's educational experiences. The study concluded that children value digital artifacts in their education, and that the iPads made a positive impact on the literacy skills of the students

involved. The integration of iPads into a classroom takes considerable time and effort, and the authors feel that the investment is worth making.

Digital storybooks are another type of app. Digital storybooks are at least somewhat interactive, and generally read the contents of a story out loud. They can range from more passive experiences to very interactive experiences. Paciga (2015) explores the topic of digital storybooks and preschoolers who are at risk of reading failure. It is widely accepted that adults reading story books to children encourages a love of reading and builds literacy skills. Paciga looks at the intriguing idea of whether or not using digital storybook apps can have similar impacts on preschool children. She studied 130 English-speaking students from low socio-economic backgrounds (classified as at-risk readers).

Paciga (2015) begins by detailing the features that digital storybooks may have. Narration and word highlighting are common. Some contain hotspots, where words or images may be interacted with. Some stories are not linear, meaning that audience has the opportunity to experience different parts of the story in different sequences, or to explore sub-plots as they choose. Video, sound, and music are often incorporated into digital storybooks. These can provide support for the meaning of words or story comprehension. Embedded dictionaries and character animations can also help provide context and meaning.

Paciga's (2015) method involved the researcher working with each student twice. The first day consisted of the researcher conducting a vocabulary assessment with the student. On the second day, the student's computer skills were assessed. It's important to note that Paciga's research was conducted on traditional computers, not tablet computers. This complicates the outcomes somewhat, as students must have the skill to use a mouse and keyboard. Students were also assessed on their knowledge of the topic of the story to be used in the study. The story

chosen for the research is *Stellaluna*, by Janell Cannon (1993). After the assessments, each child listened to one format of the story. Four different formats of the story were used. Children were then orally assessed on their comprehension of the story.

The four formats of the story all followed the same plot. Two were in a CD-ROM format, while two were web-based. Differences in the presentations included filmic effects with music and animation, extra-textual features, interactive hotspots, and the length of the overall presentation. Lengths varied from ten to twenty-five minutes, with one being determined by the user. Paciga (2015) reports that classroom read-alouds with teachers ranged from fifteen to thirty-five minutes, for purposes of comparison.

One of the outcomes examined were the number of students completing the story. Interestingly, only 1/3 of students with the most interactive version of *Stellaluna* actually completed the story. The least interactive version of the story (which was also the shortest in duration) was completed by almost all of the children who viewed it. Paciga (2015) believes that there are two causes for this. The first is that the more interactive version of the story required digital literacy skills that many of the participants hadn't yet mastered. Interacting with the mouse and keyboard was a barrier. The second factor Paciga identified was the length of the presentation. Shorter presentations led to higher completion rates.

Paciga's (2015) findings indicated no significant differences in comprehension across the four formats. Overall, scores were lower than anticipated. Paciga attributes this to several factors, including the lack of background knowledge and vocabulary included in the presentations. That the children only experienced one telling of the story is also considered. None of the presentations explicitly work to connect what the students already know to what is presented in the text.

Paciga (2015) concludes that the design of digital storybooks can be modified to mitigate some of these problems, but that digital storybooks are not a substitute for children being read to by their caregivers or teachers. The scaffolding presented by adults who know the children and can adapt the story to the children's needs cannot be replicated with digital storybooks alone. Digital storybooks, while often compelling in their concept and execution, don't provide a meaningful educational experience on their own. Pre-K teachers and administrators should avoid thinking that digital storybooks can replace teachers reading to their classes.

Handwriting instruction is an area where touch screen devices and IWBs would seem to offer considerable instructional benefits. It is easy to imagine students tracing bubble letters on an IWB, or using a letter-forming app on an iPad. Surprisingly, no research was found on this use of technology. Dinehart's (2015) research on handwriting instruction in early education makes a strong case for exploring the topic.

Dinehart (2015) begins with a discussion on the link between handwriting instruction and achievement. Visual motor integration (VMI), or fine motor skills, are taught in early childhood programs. VMI and handwriting skills are closely related. VMI has been shown to be significantly associated with performance on standardized tests. VMI is a foundational skill that predicts success in math, reading, writing, and spelling. If a child hasn't mastered VMI and handwriting at an early age, they may experience barriers to learning later.

Interestingly, Dinehart (2015) explores how the use of technology has diminished the emphasis on handwriting education. Typing and digital literacy skills are seen as being more important, so less of the limited classroom time is spent on handwriting. Dinehart reports on a correlation between handwriting speed and typing speed amongst secondary students. Dinehart

does not make a connection between (or explore the possibility of) letter-formation skills that could be taught using technology and her research.

Many early childhood programs serve bilingual students, where the student's home language is not English. Rowe and Miller (2015) examined how iPads could be used in a classroom serving English Language Learners (ELL). This two-year study focused on both how to use iPads in an early childhood setting and how those iPads could be use to help ELL students gain English language and literacy skills. Their work examined how iPads and digital cameras could be used with "open" apps to allow students to compose their own stories, both in English and their home languages. Multimodal composing was stressed, allowing for learning in a variety of ways. These included writing, drawing, photos, and voice recordings. The authors stress the inclusion of the students' home languages, as multilingual composing creates many benefits for students.

Rowe & Miller's (2015) study took place in a public Pre-K classroom serving four-year old students. Students were from a variety of language backgrounds. Most were from low-income families. Spanish was the predominant home language, with small numbers of Burmese, Nepali, and Kurdish speaking students in the first year. The second year was skewed to a slightly more diverse group, with five different home languages. Most of these students were just beginning to use English. The students had access to many traditional classroom supplies, in addition to the iPads. An experienced teacher led the classroom, assisted by a paraprofessional. Interestingly, the digital storybook composing was done with direct involvement of the two authors. The authors led the digital activities three times per week. The authors were present in the classroom from breakfast until lunch. This level of additional support in the classroom

would be very difficult for most public Pre-K programs to achieve, and likely has a significant impact on the learning outcomes.

Rowe & Miller (2015) encouraged students to use technology both at home and at school to create their stories. Inexpensive digital cameras were sent home with the students. This allowed students to capture moments, articles, and people who are important to them. These photos were then incorporated into the children's stories. Audio recordings were also included in the students' work. The stories were created by encouraging the students to draw, take photos, and to talk about what they had captured. The researchers found that as time went on, less and less scaffolding was required for the students to successfully create or capture their story elements. Common difficulties and frustrations were soon identified, and the researchers become more comfortable in helping the students overcome barriers to their digital creation work.

Rowe & Miller (2015) examined a sample of 20 student-created eBooks. Most of the books focused on naming photos or drawings with short captions. Some students used a digital artifact as the basis for a remembrance or explanation. Imaginary play and narration was also common. Some students focused on exploring the iPad's content creation tools, rather than on creating a story. Written work could be described as brave attempts at spelling, which is a positive outcome. The written work included both typed text and handwriting (on the screen and in photographs). Early in the school year, most messages were verbal recordings. As the school year progressed, students tended to use more written messages. Both verbal and written messages were done in a mix of home languages and English. In the first year, only Spanish and English were used in audio recordings. Students who spoke other languages at home appeared to be reluctant to make audio recordings of their home language. This was an unexpected result

that the researchers worked around in the second year, with directed recordings in all students' home languages.

Rowe & Miller's (2015) findings were encouraging about the use of open apps and digital artifacts, such as photos and audio recordings. Students were able to tell stories about things in their classrooms and homes that they found interesting. The photos helped adults to understand the context for the students' written work. Allowing students to take cameras home broadened the experience and engagement, and allowed the students to share more of their lives through their stories. The authors conclude that the outcomes for students are positive, although they did not provide any quantitative evidence of this. The qualitative evidence did not include the classroom teacher's thoughts, which is unfortunate. The classroom teacher's evaluation of the impact that the digital storytelling had would have been very meaningful. Assessment of growth related to young children's achievements involving technology is a difficult to measure.

Assessing young students in their journey to digital literacy is also difficult to do. Ntuli and Kyei (2012) explored this topic. Their research focused on how teachers assess students' growth in technology skills. The focus was on K-3 teachers, but their findings are very likely to be useful in an early childhood setting. The researchers conducted surveys with 54 teachers and then did one-hour interviews with ten of the teachers.

The vast majority of the teachers surveyed (80%) said that they don't assess students in their use of technology. Various reasons were given as to why that's the case. Many of the teachers stated that much of the classroom technology use is done during "free-choice" time. This is time that students spend working independently. This is reflective of technology use in early childhood programs, where much of the technology use is during free-choice time. It is

reasonable to conclude that many early childhood teachers would cite the same reason for not assessing the technology skills of their students (Ntuli and Kyei, 2012).

Teachers who did not collect assessment data about technology use shared some barriers that they struggle with. Many programs or apps don't collect assessment data. The apps that do collect the data may present it in a way that teachers don't know how to use. Teachers need training on how to interpret and analyze data collected from the apps that are used in their classrooms. Some teachers also do not consider students using technology to be engaged in learning, particularly if games are being played. In early childhood settings, students often spend time playing with, but not actually using, computers. They are engaged in mimicking what they see adults do, and one can surmise that some early childhood teachers may see technology use in the same way that their K-3 counterparts do (Ntuli and Kyei, 2012).

Ntuli and Kyei (2012) conclude that most K-3 teacher lack assessment strategies relating to technology. These teachers can't measure their students' digital literacy progress. The lack of ability to assess students makes it very difficult to conduct meaningful technology-related or infused lessons. Strategies identified that could be used include observation, evaluating the work created by students while using technology, and surveying students about their skills. Checklists are suggested to help with observational strategies. The authors also stress that administrators must include effective professional development centered around technology assessments.

Screen-Time Concerns

Many caregivers and educators have come to be concerned about the amount of time children spend viewing screens (Simon, Nemeth, and McManis, 2013). Vanderloo's (2014) research examines how long children spend in front of screens in different settings. Vanderloo begins with some frightening statistics. Children in the United States between the ages of four

and seven spend an average of 1.5 to 7.0 hours on screen-viewing per day. Screen-viewing takes up more of their time than any other daily activity, other than sleeping. Too much screen-viewing can lead to blood pressure problems, obesity, poor sleep habits, and behavioral and academic issues. These years play an important role in health-related habit formation. The author includes that the American Academy of Pediatrics recommends that children over two are limited to two hours or less of screen-time per day.

Vanderloo's (2014) research explores the idea that a significant amount of screen-viewing may take place outside of the home, when the children are in childcare or a preschool setting. Vanderloo's work makes no distinction between different types of screens. Using a computer, watching a movie, viewing a lesson on an interactive white board, and playing a game on a tablet computer are all treated as equivalents. The sedentary nature of screen-viewing is Vanderloo's primary concern. Vanderloo's research indicates that between 0.1 and 1.3 hours per day of screen-viewing occurs in a preschool setting. This does not include the average of 3.1 hours that these children spend each day watching screens outside of school. This total is far in excess of the recommended two hours.

In 2012, the National Association for the Education of Young Children and the Fred Rogers Center for Early Learning and Children's Media at Saint Vincent College published a position paper on the use of technology in Pre-K classrooms. The paper differentiates between interactive and non-interactive screen-viewing. This is an important distinction from Vanderloo's (2014) work. The position paper defines non-interactive media to be videos, in any format. Non-interactive is only considered to be effective nor appropriate in an early childhood setting if it is used in ways that promote active engagement and interactions. Non-interactive

media would include digital storybooks that have no audience interaction features. The paper stresses that non-interactive media should not be confused with engaging uses of digital media.

The paper echos Vanderloo's (2014) concerns about the impact of all forms of screen-time on young children. It warns against any passive use of technology. The paper recommends that schools limit screen time, following the recommendations of public health officials. The paper cites research suggesting that half-day programs limit interactive screen-time to under one-half hour per day, with full-day programs limiting the time to under one hour per day. These may be challenging recommendations for programs that have richly-equipped classrooms. Program administrators must carefully evaluate how technology is integrated into their curricula. Striving to find a balance between the benefits and dangers of technology use may prove difficult to accomplish.

Discussion and Recommendations

Program administrators thinking about how to integrate technology in early childhood curricula face a daunting task. There are challenges present in every aspect of the process, including planning, funding, staff development, curriculum design, assessment, and balance. While research-based decision-making is ideal, there isn't a large amount of Pre-K specific research available. Large gaps exist in areas such as types of technology to deploy, software/app selection, lesson design, and whether or not the large investment all of this takes produces tangible, measureable results. Considerable research has been done with older children, but the needs of older students are different from the needs of Pre-K students.

Hardware selection and long-term funding are challenges that largely haven't been addressed through research. Administrators are rarely lucky enough to have resources available to make use of all possible technologies (Simon, Nemeth, and McManis, 2013). Choices must

be made as to which technologies to pursue. Often, the choice is between interactive white boards and tablet computers. Both present very different uses of technology. Interactive white boards lend themselves to large group activities (Linder, 2012), while tablets are a more natural fit for small group activities. Interactive white boards work best with teacher-led instruction, while tablets are better suited for more independent activities (Flewitt, Messer, and Kucirkova, 2015). It would be ideal to have access to both technologies. Programs that have fewer resources (including the rare-but-critical professional development opportunities) need to consider what activities they feel would most benefit their classrooms. Additional research comparing the two technologies and their learning outcomes would be very beneficial.

Software selection is another area in which school leaders are often left without much guidance. Apps for tablets covering early childhood content areas are plentiful, but how does one separate the wheat from the chaff? Program administrators are faced with a daunting task in deciding which pieces of software are right for their classrooms. There are free apps, paid apps, and subscription apps. Each model has its benefits and drawbacks. More importantly, the cost of an app may not be indicative of its quality or effectiveness. There are no credible, recognized sources that recommend specific apps for Pre-K classrooms. Forming teams to evaluate and recommend apps is an expensive, time-consuming use of resources. Perhaps one solution is to partner with other Pre-K programs to share data and experiences. Research does show that apps that have reporting functions, such as student scores or progress, can provide meaningful data (Ntuli and Kyei, 2012). The research also shows that without intentional, focused staff development training, those reports often go unused. Targeting specific learning standards is also a useful strategy in app selection (Hutchinson and Woodward,2014).

.

Closely related to app selection is the concept of "open" versus "closed" educational apps (Flewitt, Messer, and Kucirkova, 2015). Open apps encourage student-created work and learning, where closed apps emphasize rote learning or "drill and kill." Research shows that Pre-K students are capable of effectively using open apps, but the students need good instruction and help as they progress in their digital literacy journey (Rowe & Miller, 2015). Closed apps may help students to master areas where they need additional repetition or practice. Both styles are viable and have their place.

Effective lesson design is critical to technology being successfully integrated into Pre-K classrooms. Teachers must be supported in their work. Hutchinson and Woodward's (2014) research on effective technology lesson planning should be taught in professional development courses for Pre-K teachers. Their thoughtful, practical approach to incorporating technology will lead to better outcomes for both teachers and students. The process they suggest will also build confidence in teachers, and help to prevent classroom technology from going unused.

Budget planning is also an area where further research is needed. How much technology is appropriate and what does it cost to maintain and replace it? How much professional development time is necessary? Depending on the type of technology selected, software costs may be considerable. Hardware, by itself, is no more useful than a vehicle without fuel.

Significant care must also be given to screen-time concerns (Vanderloo, 2014). Given the expense of technology and the cost of integrating it into a curriculum, there may be a desire to make frequent use of it. Teachers may also use individual devices, like tablets, as a sort of pacifier. Thoughtful administrators will set appropriate limits on the duration of technology use in their classrooms (National Association for the Education of Young Children and the Fred Rogers Center for Early Learning and Children's Media at Saint Vincent College, 2012). More

research is necessary to differentiate active vs passive uses. Is instruction using an interactive white board really equivalent to watching a video, or is it more akin to traditional instruction on a white board? Should open apps that encourage students to tell their own stories or document their experiences be weighted the same as time spent practicing rhyming with a closed app? What types of screen-time provide the most time-effective outcomes for students? The answers to these questions would help to shape what our classrooms will look like in the coming years. In the meantime, cautious and considerate utilization of screen-time is the best practice (National Association for the Education of Young Children and the Fred Rogers Center for Early Learning and Children's Media at Saint Vincent College, 2012).

There are many challenges that technology in early childhood education presents, but there are also great opportunities. Work needs to be done to determine the best uses of technology in differentiated education, targeted-interventions, and the impact of gaining digital literacy skills at an early age. There is so much promise in being able to help prepare children for Kindergarten through multi-modal instruction.

Pre-K children generally use technology on a frequent basis (McKenny and Voogt, 2010). They often have access to technology both in their classrooms and at home (McKenny and Voogt, 2010). The challenge we have is to ensure that the time they spend using technology is well spent. This is a difficult, yet achievable, goal. With proper planning, balance, and thoughtful consideration, we can provide better outcomes for Pre-K learners through the integration of technology. It is important not to lose sight of the limits of technology. Technology is not a panacea that can turn an ineffective program into an award winner. Technology use is a supplement and component of skilled, thoughtful teaching, not a replacement for teaching.

References

Dinehart, L. (2015). Handwriting in early childhood education: Current research and future implications. *Journal of Early Childhood Literacy*, *15*(1), 97-118.

Flewitt, R., Messer, D., & Kucirkova, N. (2015). New directions for early literacy in a digital age: The iPad. *Journal of Early Childhood Literacy*, *15*(3), 289-310.

Hutchinson, A. & Woodward, L. (2014). A planning cycle for integrating digital technology into literacy instruction. *The Reading Teacher*, *67*(6), 455-464.

Linder, S. (2012). Interactive white boards in early childhood mathematics: strategies for effective implementation in pre-k-grade 3. *YC Young Children*, 67 (3), 26-32, 34-35.

Lyons, C. D., & Tredwell, C. T. (2015). Steps to implementing technology in inclusive early childhood programs. *Computers in the Schools, 32*(2), 152-166.

McKenney, S. & Voogt, J. (2010). Technology and young children: How 4-7 year olds perceive their own use of computers. *Computers in Human Behavior*, 26, 656-664.

Nemeth, K. K., & Simon, F. F. (2013). Using technology as a teaching tool for dual language learners in preschool through grade 3. *YC: Young Children*, *68*(1), 48-52.

Ntuli, E. & Kyei, L. (2012). Teacher assessment of young children learning with technology in early childhood education. *International Journal of Information and Communication Technology Education*, *8*(4), 1-10.

Paciga, K. (2015). Their teacher can't be an app: Preschoolers' listening comprehension of digital storybooks. *Journal of Early Childhood Literacy*, *15*(4), 473-509.

Rowe, D. & Miller, M. (2015). Designing for diverse classrooms: Using iPads and digital cameras to compose eBooks with emergent bilingual/biliterate four-year-olds. *Journal of Early Childhood Literacy*, *0*(0), 1-48.

Simon, F., Nemeth, K., & McManis, D. (2013). Technology in ece classrooms: Results of a new survey and implications for the field. *Exchange*, *35*(5), 68-75.

Technology and interactive media as tools in early childhood programs serving children from birth through age 8. (2012, January). Retrieved February 12, 2016, from http://www.naeyc.org/files/naeyc/file/positions/PS_technology_WEB2.pdf

Vanderloo, L. (2014). BMC Pediatrics. Retrieved February 12, 2016, from http://bmcpediatr.biomedcentral.com/articles/10.1186/1471-2431-14-205