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The use of touchscreen devices to support writing development of preschoolers

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The use of touchscreen devices to support writing development of preschoolers

Abstract

This review examines the use of touchscreen devices to support writing development of preschool children. Examination of the impact of touchscreen device writing on brain development of preschoolers is also included. Benefits and challenges of using touchscreen devices to support handwriting development are analyzed and reviewed along with recommendations for classroom implementation, future research, and educational policy.

THE USE OF TOUCHSCREEN DEVICES TO SUPPORT WRITING

DEVELOPMENT OF PRESCHOOLERS

A Graduate Review

Submitted to the

Division of Early Childhood Education

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Celeste Mortvedt

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ABSTRACT

This review examines the use of touchscreen devices to support writing development of preschool children. Examination of the impact of touchscreen device writing on brain development of preschoolers is also included. Benefits and challenges of using touchscreen devices to support handwriting development are analyzed and reviewed along with recommendations for classroom implementation, future research, and educational policy.

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CHAPTER I

Introduction

Touchscreen devices are commonplace in modern society. This review will analyze research pertaining to the benefits and determinants of using touchscreen devices to support writing development in preschool children. The review will also reveal information about how touchscreen use impacts learning and brain development of preschool children specifically relating to fine motor and writing skills. Finally, the review will examine research, which provides specific parameters for the developmentally appropriate use of touchscreen devices with preschool children, including implications for the design of applications and for touchscreen use in the preschool classroom.

The use of touchscreen devices by young children is an issue facing parents, caregivers, and educators. The Internet is abundant with resources that set parameters for the amount of time spent using technology as well as content and skills addressed by interactions with technology.

Touchscreen Device Use in the Home

In our society, it has become the norm to observe children interacting with touchscreen devices both publically and in the home. According to Common Sense Media, 75% of children ages zero to eight years have a mobile device (smartphone, iPad, or iPod Touch) in their home (Common Sense Media, 2013). Seventy-two percent of children ages zero to eight have used this mobile technology (Common Sense Media, 2013). Parents and caregivers are faced with the challenge of providing screen time

limits to children. The American Academy of Pediatrics recommends that children have no more than one hour of screen time each day (American Academy of Pediatrics, 2017). With increased access and time limitations, it is imperative that parents and caregivers help children select touchscreen device activities that are developmentally appropriate and cognitively stimulating (National Association for The Education of Young Children (NAEYC), Fred Rogers Center, Children's Media at St. Vincent's College, 2012).

Educators face similar challenges related to the use of technology as an enhancement to core content. They must adhere to time limitations while still considering ways to help children build digital literacy and digital citizenship (NAEYC et al., 2012).

Touchscreen Device Use in Schools

One of the guidelines for technology use presented by the National Education for the Education of Young Children (NAEYC), the Fred Rogers Center for Early Learning, and Children's Media at St. Vincent's College states that "developmentally appropriate practices must guide decisions about whether and when to integrate technology and interactive media into early childhood programs" (NAEYC et al., 2012, p. 5).

The aforementioned guideline stresses the importance of teachers using technology with intentionality. Educators must understand how the use of different types of technology impacts the development and learning of their students.

Selection of Touchscreen Device Content and Interactions

Touchscreen devices can compliment teaching but do not replace traditional classroom instruction and activities. This review will address ways that touchscreen interactions can enhance the learning experiences of preschool children.

There is tremendous pressure for educators to provide developmentally appropriate, quality interactions with technology (NAEYC et al, 2012); however, limited professional development time is devoted to learning strategies and supports related to technology. Professional learning focused on the use of technology in the classroom is imperative in order for educators to keep up with the ever-changing world of technology while also meeting the guidelines and recommendations described above.

Relevance of the Research

Research related to the use of touchscreen devices is very limited; while the number of children using touchscreen devices continues to climb. Studies support the idea that touchscreens can be used as a tool to support the development of writing skills in preschool children. The use of touchscreen devices and other technology cannot and should not replace traditional preschool classroom learning activities (NAEYC et al, 2012).

The study of the relationship between handwriting instruction and the use of touchscreen devices yields information that can impact how teachers use these devices to support learning and development in the classroom. Analysis of research related to the impact of touchscreen technology on brain development of preschool children can provide insight for educators as they plan and implement technology experiences.

With an abundance of available touchscreen device applications, it is easy to be uncertain of their value and credibility. This review of research examines qualities of applications that make them developmentally appropriate options for preschool children.

Application

The results of this review will help parents, caregivers, and educators gain a better understanding of how to best implement touchscreen technology in the home or classroom setting. It will provide characteristics of applications that are best suited for preschool children, as well as the background of research for the development of these objectives.

Due to the ever-evolving nature of technology, terms and language are also changing. This study of research related to the use of touchscreen devices has yielded several terms that must be appropriately defined.

Important Terms

For the purpose of this review, touchscreen device refers to any electronic device manipulated by touching a screen with one's finger(s) or a stylus. This includes tablet computers, mobile phones, and iPads. Visual-motor skills refer to the connection between what a child sees (visual perception) and their physical movements.

It is important to define the terms essential for the understanding of this review. One must also be informed of the questions that have guided this review and analysis.

Research Questions

To gather and synthesize the research related to using touchscreen devices to support writing development of preschool children, I considered the following questions:

1. What impact does using a touchscreen for writing activities have on the writing development of preschoolers?
2. How does using a touchscreen device impact the brain development of preschoolers?
3. How can preschool teachers select and implement developmentally appropriate touchscreen interactions?

CHAPTER II

Review of Research

Understanding current research related to the use of touchscreen devices to support writing development will help teachers and other educational professionals become more intentional with quality use of touchscreen technology in the classroom. The following questions will be addressed in this section:

1. What impact does using a touchscreen for writing activities have on the writing development of preschoolers?
2. How does using a touchscreen device impact the brain development of preschoolers?
3. How can preschool teachers select and implement developmentally appropriate touchscreen interactions?

There are many variables and ideas that must be understood in order to understand how touchscreen devices impact the writing development of preschoolers. For this review, I will start with a brief analysis of research related to how preschoolers develop writing skills.

Components of Effective Writing Instruction for Preschoolers

In an attempt to determine the effect of multisensory letter training activities on preschool children, Labat, Vallet, Magnan, and Ecalle (2015), formed five groups of participants. Each group received a 25 minute training session centered around handwriting and letter skills using one of the following approaches: visual, multisensory, graphomotor, visual and multisensory, or visual and graphomotor. Pre and posttest data

indicated the benefit of pairing visual and multisensory learning experiences in order to maximize writing development of preschool age children (Labat et al., 2015). Their research found that an approach to writing instruction, which includes multisensory writing experiences, paired with visual representations of letters promoted reading and spelling, as well as writing (Labat et al., 2015). The multisensory approach also seemed to help the children retain and retrieve letter knowledge (Labat et al, 2015).

Bara and Gentaz (2011) also conclude that receiving a combination of visual and hands on instruction yields more refined handwriting development in preschool children. Bara and Gentaz began with a baseline assessment of letter recognition, phoneme identification, and loop tracing skills of each participant. The participants were then divided into two groups; one group received only visual instruction related to the instruction of writing five targeted cursive letters, while the other received both visual instruction and the opportunity to interact with letters in multisensory ways. Posttest results indicated that the children who received the combined instruction showed increased letter recognition and handwriting quality (Bara & Gentaz, 2011). This led Bara and Gentaz (2011) to conclude that if children truly understand the shapes of letters they are much better at writing them.

Vinter and Chartrel (2010) also studied the benefits of teaching handwriting with a motor component. They divided their participants into four groups: one group received only visual instruction, one only multisensory instruction, one both visual and multisensory instruction, and one control group which did not receive any handwriting instruction at all. The instruction focused on cursive writing of the letters f, l, m, and r. All groups were given a pre- and a posttest, and each were scored based on four criteria

established by the researchers. Analysis of pre- and posttest data indicated that all groups showed progress over the control group, which indicates that handwriting instruction is beneficial for students. The researchers also found that students who received the combined visual and motor instruction had the quickest rate of progress. This led them to conclude that a handwriting program that incorporates both multisensory and visual learning opportunities is optimal (Vinter & Chatrel, 2010).

James and Engelhardt (2012) studied how handwriting experiences activate different regions of the brain. The researchers studied MRI results of children taken as they were shown a capital letter or shape and asked to trace, draw, or type it eight times. Their research found that after practicing printing letters, the brain begins to respond differently to letter versus shape perception (James & Engelhardt, 2012). As a result of their research, James and Engelhart conclude that free writing has a greater impact on brain development than tracing letters (2012). They attribute this to the fact that understanding how letters are formed, has an impact on how the child learns letters and begins to identify and categorize them (James & Engelhardt, 2012).

James and Gauthier (2006) also study how the brain is activated when reading and writing. Their study involved showing pictures of objects, faces, and letters to adult participants while they sat in a whole body MRI system with a stylus in one hand. After seeing an image, they drew their response to the picture. The MRI collected information about each participant's brain response to the image shown. The researchers were able to isolate the parts of the brain that are stimulated during letter writing. They found that for most people, the motor portions of the brain are activated alongside the visual recognition

portions when shown letters (James & Gauthier, 2006). This supports the idea that handwriting instruction should have a multisensory component.

At a glance, a touchscreen surface and a piece of paper have some of the same qualities. They are both smooth surfaces and both are typically rectangular in shape. One must carefully analyze student performance on each surface to gain a better understanding of their similarities and differences.

How does writing on a touchscreen compare to writing on paper?

Writing velocity on a tablet is much faster than writing velocity on a paper surface (Gerth et al., 2016). In this study, adult participants copied continuous movement patterns (wavy lines, looped lines, etc.), shapes and a phrase using a specialized pen that measured their pressure sensitivity and writing velocity on a tablet and on paper. Gerth et al. found that when writing on the tablet the participants reduced the pressure on the surface (2016). They related this to the decrease in friction on the tablet surface, which caused the participant to write more quickly (Gerth et al., 2016).

In a follow-up study, Gerth et al. extended their participant group to include both children and adults (2016). The participants in this study completed writing tasks in two ways. One writing sample was with a stylus on a touchscreen and the other with a pen on paper set on top of a digitizer that recorded velocity, pen lifts, and accuracy. The writing requirements included writing repetitive patterns of loops, wavy lines, and zigzags in addition to copying shapes, connecting dots, and copying a phrase. Analyzing the results of preschool children, second graders, and adults indicated that preschool children had reduced accuracy when writing on the tablet surface (Gerth et al., 2016). Gerth et al.

attribute this to the fact that more immature writers lack the ability to adjust their pressure on the surface, which results in decreased quality of writing due to the increase in the writing speed on the tablet surface (2016). The authors recommend that tablet writing be limited in children under age ten due to their underdeveloped motor skills and inability to control their speed when writing on the touchscreen surface (Gerth et al., 2016).

Crescenzi, Jewitt, and Price (2014), studied the drawing and writing of children using paint and paper, as well as using two touchscreen applications that allow the user to draw freely: Doodle Buddy and The Coloring Zoo. The researchers video recorded the children as they completed their finger paintings on paper and digitally. The researchers used a coding system in order to analyze the type and quality of touch used by the children. They found that children displayed more complex sequences of touch on the iPads, which was attributed to their previous experiences with touchscreen technology. Crescenzi et al. (2014) deduce that while children can develop finger control such as the use of 'drag and drop,' with the use of iPad applications, they miss out on the multi-sensory nature of finger-painting. The authors also write that it may be beneficial for teachers to consider the type of activity before making the decision to allow children to use a touchscreen or paper surface. They recommend using a touchscreen for writing and drawing activities that require more precision and paper for more creative, open-ended activities (Crescenzi et. al, 2014). Crescenzi et al. (2015) furthered their analysis to note that some children were limited in their creations with paint and paper, as they did not want to get their hands messy. The researchers question the implications this has for children who may have a sensory deficit; for these children, using the iPad may

encourage creative expression in ways that traditional paint and paper cannot (Crescenzi et al., 2015).

Picard, Martin, and Tsao (2014) invited children to visit a “drawing workshop” in their classroom. The workshop provided the opportunity for the participants to draw a house on a touchscreen device, as well as on a piece of paper cut the same dimensions as the touchscreen. Each drawing was analyzed and scored by two judges who considered the components present in the drawing including: outline, roof, chimney, door, window(s), and a variety of other details. Picard et al. (2014) found that children included fewer details in their iPad drawings and the overall quality of the iPad houses was lower than that of the houses drawn on paper. They attribute these differences to the dexterity and lack of experience that children have with using their pointer finger to draw versus holding a crayon to draw (Picard et al., 2014). It is important to note, however, that the participants in this study did not have any previous experience with an iPad. The image below shows one participant’s completed drawings. The drawing on the left was completed on paper with a marker and the drawing on the right was completed on the touchscreen device.

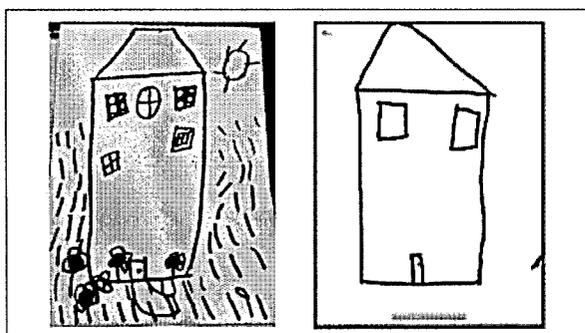


Figure 1. House drawings produced in the standard (left) and iPad (right) conditions by a 5-year-old girl. Loss of detail can be observed in the finger drawing (iPad condition).

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Figure 1. House drawings (Picard et al., 2014, p. 209)

Patchan and Puranik (2016) tested and analyzed how children write with their finger on an iPad, with a stylus on an iPad, and with a pencil on paper. They divided the preschool students into three groups; one group addressed each of the aforementioned writing methods: iPad and finger writing, iPad and stylus writing, and paper and pencil writing. An instructor taught each group one letter each week and then provided five minutes for the participants to practice writing the targeted letter using the method that corresponded to their group. The two groups using the iPad technologies received corrective feedback from the iPad application if they digressed too far from the correct letter formation during the writing practice. Researchers administered a letter writing assessment at the start of the study as well as at the end. Patchan and Puranik (2016) found that the children in the pencil and paper group wrote the letters more times during the five minute practice sessions, but did not perform any better on the posttest than the other groups (Patchan & Puranik, 2016). The data from this study also showed the children who used the iPad and their finger to practice may have better-developed writing skills due to the hands on nature of their writing practice (Patchan & Puranik, 2016). This lead the researchers to conclude that there may be a benefit to iPad practice of handwriting skills using the pointer finger over traditional pencil and paper practice (Patchan & Puranik, 2016).

While there are marked differences between writing on a touchscreen device and writing on paper, both mediums are present in the lives of most children and adults and warrant further analysis to ensure they are used effectively. The subsequent section will synthesize research related to the benefits of using touchscreen devices in the classroom.

What are the benefits of using touchscreen devices in the classroom?

Wollscheid, Sjaastad, Tomte, and Lover (2016) compared student writing samples (transcription of a text, dictation, and free writing) using pen and paper and on a tablet computer. The researchers analyzed writing samples collected from each participant and analyzed the number of words used, as well as the speed and accuracy of their writing. The data analysis showed that the students who used the tablet computers wrote 41% more words than the students using pen and paper (Wollscheid et al., 2016). This led the researchers to conclude that students may be more motivated to write when using a tablet computer (Wollscheid et al., 2016).

Couse and Chen (2010) also found that children seemed to be increasingly motivated to write when using a tablet computer. Their study of three to six year old participants included four phases:

- Phase 1: The researchers taught the participants how to use a tablet computer.
- Phase 2: The researchers asked each participant to draw a self-portrait on the tablet computer.
- Phase 3: The researchers interviewed the children to get feedback on their experience with the tablet.
- Phase 4: The researchers interviewed the teachers and discussed the difference in student performance on tablet self-portraits versus paper self-portraits.

Analysis of the Phase 3 interview data showed that 64.10% of the children preferred drawing a self-portrait on the tablet to drawing on paper (Couse & Chen, 2010). Couse and Chen (2010) also analyzed how quickly the children learned to use the software on

the tablet computer and found that after a brief instruction and some modeling, the children were able to manipulate the features of the application independently (Couse & Chen, 2010).

Children are quick to master the skills needed to interact with touchscreen devices. Research is available which provides characteristics of touchscreen applications that are best suited for preschool children.

What are the characteristics of touchscreen applications that are developmentally appropriate for preschool children?

Vatavu, Cramari, and Schipor (2015) studied the development of touchscreen manipulation skills in children between the age of three and six years, and the relationship between these skills and typically developing motor skills. This study involved using software formatted for a smart phone and tablet. The software included activities that challenged the participant to tap, double tap, single-touch drag, and drop. The researchers analyzed the percentage of success for each participant, how long it took them to finish each task, how accurate the participant was with touching the target, and how accurate the path was during the drag and drop portions. The data from this study showed that children were more accurate tapping on the smartphone screen than the tablet (Vatavu et al., 2015). Further data analysis showed that the older the child, the more accurate their touchscreen manipulation. This led the authors to conclude that touchscreen manipulation skills become more refined with age, just as do fine motor skills (Vatavu et al., 2015).

Vatavu et al. (2015) use the results of their research to develop specific recommendations to meet the developmentally appropriate needs of young children as they interact with touchscreen devices. These recommendations include: selecting content with which the user can find success (not too difficult, but challenging enough for them to maintain engagement), provisions for students to use their ever-changing motor skills, activities to do independently, activities that promote creativity and the use of imagination, are reinforcing to the user, and do not include multi-touch activities (Vatavu et al., 2015).

Anthony, Brown, Nias, Tate, and Mohan (2012) studied the accuracy of children and adults as they tapped and drew on touchscreen devices. This study was completed in two phases:

- Phase 1: The software required participants to tap a target on the screen. The screen would only advance when the target was accurately tapped. The software recorded the number of taps by each participant before they hit the target.
- Phase 2: The software prompted the participant to write a letter using their finger. After writing the letter, the participant would push a “done” button to advance to the next screen.

The data generated from this study reveals that children are less accurate with tapping items on a touchscreen and that children exert less pressure on the screen than do adults (Anthony et al., 2012). As a result of the data from this study, the researchers

recommend that touchscreen applications designed for children should include larger targets, more touch sensitivity, and greater allowance to interpret the intent of child touch (Anthony et al. 2012).

Dexterity is an important component for touchscreen application use. Nacher, Jaen, Navarro, Catala, and Gonzale (2015) recorded touchscreen gestures of children between the ages of 24 and 38 months including:

- Tapping
- Double tapping
- Long pressing
- Scaling up
- Scaling down
- One finger rotating
- Two finger rotating

An instructor presented each participant with five minutes of learning after which the child would perform a task on the touchscreen device without assistance. Specialized software recorded each child's interactions with the touchscreen. Analysis of these results indicates that most children have the ability to perform these complex gestures in their touchscreen interactions (Nacher et al., 2015). Nacher et al. (2015) recommended that application developers consider these gestures and the potential abilities of children, as they design applications that allow children to practice and refine the aforementioned touchscreen gestures.

Falloon (2013) developed an analysis framework to determine the level of problem solving that each student participant used during interactions with applications on a touchscreen device. For this study, teachers selected 45 touchscreen applications based on these criteria: how the application fit with the instructional goals of the lesson, the way the students respond to using the application, online reviews of the application, the rating of the application in the app store, and the cost of installing the application on multiple devices. The teachers gave the students time to select from five applications each day. The researchers used a display reader to record every move the students made within each application. Analysis of the data collected by Falloon (2013) suggests that application design and content can serve three functions for learners: it can support learning, may impede learning and may place boundaries around learning. The applications that supported learning included components such as: wait time, an overview of learning goals prior to starting the activities, and allowing children to check their answer before hitting the “submit” button (Falloon, 2013). Some of the application features that distracted from student learning included: pop-up advertisements, external web links, and banner advertisements (Falloon, 2013). Time limits, limited workspace, and in-app purchases all seemed to place limits on learning (Falloon, 2013).

The research described in this section presents characteristics of touchscreen applications that will benefit young learners. One must also consider how teachers can be effectively supported in their use of touchscreen devices in the classroom to enhance teaching.

How is touchscreen technology applied in the classroom?

Blackwell, Lauricella, and Wartella (2014) surveyed teachers regarding the frequency, types, and purposes of their technology use in the classroom. The survey included 47 questions related to the frequency, types, and purposes of technology use in the classroom. The participants rated each item on a scale from never to daily. Analysis of the survey results found several factors that may influence technology use including:

- **Experience:** Teachers with more years of experience used technology less than newer teachers.
- **Teacher Confidence:** Teachers who rated themselves as more confident with using technology had better attitudes about using the technology.
- **Socioeconomic Status (SES) of Families:** Teachers serving lower SES families had more positive attitudes about technology, than teachers serving higher income families.

Lindahl and Folkesson (2012) analyzed the reflections of teachers after the implementation of a technology lesson. This qualitative study found that most teachers view technology as a useful tool to amplify learning experiences for their students. The participants noted that the children responded very positively to the use of technology and attributed this to the connections made to technology use at home (Lindahl and Folkesson, 2012). One of the negative aspects of technology integration noted by the participants was that the computer did not allow for multisensory, open-ended experiences that traditional manipulatives offer (Lindahl and Folkesson, 2012).

Beschorner and Hutchison (2013) researched how teachers use touchscreen devices in preschool classrooms. Researchers provided six iPads for the teacher participants to use in their classrooms. The researchers selected the applications that were installed on the iPads; but the teachers were allowed to decide how and when to use them in the classroom. Researchers analyzed digital work samples, as well as data from teacher and parent surveys, which led to the development of six themes that capture the ways that touchscreen devices can be used as a classroom tool:

- Digital environmental print
- Emergent writing using digital technology
- Using a keyboard to form writing
- Functions of writing
- Connecting reading, writing, listening and speaking
- Social learning

There are many variables that impact the use of touchscreen devices as a classroom enhancement. Each variable must be examined and evaluated in order to make recommendations for best practice.

Synthesis of Research

The use of touchscreen devices for writing activities may impact the writing development of preschool children. Touchscreen devices support a multisensory approach to handwriting instruction. Research has found that pairing visual and multisensory modalities provides the most effective way to teach handwriting (Bara & Gentaz, 2011; Labat et al., 2015; Vinter & Chatrel, 2010). Furthermore, research

conducted by Patchan and Puranik (2016) indicates that there may benefit to iPad practice of handwriting skills using the pointer finger over traditional pencil and paper practice.

To further support the importance of multisensory learning experiences related to handwriting skills, James and Gauthier (2006) explain that for most people, the motor portions of the brain are activated alongside the visual recognition portions when shown letters. Additional research demonstrates how the brain responds to letter versus shape perception. James and Engelhardt (2012) conclude that free writing has a greater impact on brain development than tracing letters. They attribute this to the fact that understanding how letters are formed, has an impact on how the child learns letters and begins to identify and categorize them (James & Engelhardt, 2012).

There are many considerations that teachers must make regarding the use of touchscreen devices in the classroom in addition to the multisensory approach. Teachers may find increased student motivation to write when using a touchscreen device (Couse & Chen, 2010; Wollscheid et al., 2016). Teachers must consider the developmental level of a student when pairing them with touchscreen devices and applications. Vatavu et al. (2015) recommend that teachers select content with which the user can find success (not too difficult, but challenging enough for them to maintain engagement), make provisions for students to use their ever-changing motor skills, plan activities to do independently, plan activities that promote creativity and the use of imagination, are reinforcing to the user, and do not include multi-touch activities (Vatavu et al., 2015). Teachers should consider selecting touchscreen applications that include components such as: wait time, an overview of learning goals prior to starting the activities, and allowing children to

check their answer before hitting the “submit” button (Falloon, 2013): Teachers should avoid applications with pop-up advertisements, external web links, and in-app purchases as they may distract from the instructional goals (Falloon, 2013).

This research supports the use of touchscreen devices in the preschool classroom to enhance the writing development of students. Specifications and standards can be derived from these studies to empower teachers to implement developmentally appropriate, high quality applications as teaching tools.

CHAPTER III

Use of Touchscreen Devices to Support Handwriting Development

Pairing visual and multisensory modalities provides the most effective way to teach handwriting (Bara & Gentaz, 2011; Labat et al., 2015; Vinter & Chatrel, 2010). The research suggests that the integration of touchscreen devices into handwriting curriculum could produce optimal learning opportunities for students. It is imperative that teachers consider all available resources when planning for handwriting instruction and practice. Based on this finding, students might learn best when letters are presented visually and they are allowed to create them in a variety of hands-on ways. In addition to touchscreen applications; this could include dry erase boards, chalkboards, or building letters with buttons or other small materials.

The finding that free writing has a greater impact on brain development than tracing letters (James & Engelhardt, 2012) suggests that teachers should avoid handwriting practice that involves tracing letters. In lieu of tracing, students should be given opportunities to build and write letters with a visual model. Patchan and Puranik (2016) cite benefits to touchscreen practice of handwriting skills using the pointer finger over pencil and paper practice. Teachers can select touchscreen applications which allow students to write with their pointer finger, but allow for free writing over tracing letters. In addition to letter writing practice with the pointer finger on the touchscreen; teachers could consider planning opportunities for students to write letters in salt trays, finger paint, or shaving cream.

Teachers must use touchscreen devices with intentionality in the classroom.

While it is important for teachers to take into consideration the purpose behind the touchscreen interactions, it is also important for teachers to be aware of the characteristics of touchscreen devices that are best suited for their students.

Selection of Touchscreen Applications

Teachers should carefully consider the characteristics of touchscreen applications that will be the most beneficial to the needs of their students (Falloon, 2013; Vatavu et al., 2015). This statement implies that teachers need to be knowledgeable about the variety of touchscreen applications available, and how they can address the needs and abilities of students. This research supports the need for school districts to provide ongoing professional learning opportunities centered on the use of touchscreen device applications. Teachers must be up to date with the newest available touchscreen device applications and their implications for classroom use.

Research by Falloon (2013) led to the recommendation of characteristics of touchscreen applications that are ideal for classroom use. These recommendations include selecting touchscreen applications with the following components:

- wait time
- an overview of learning goals prior to starting the activities
- the opportunity to check an answer before hitting the “submit” button
- no pop-up advertisements, external web links, and in-app purchases (Falloon, 2013)

School districts could provide teachers with a reflection form or survey to complete after exploring a touchscreen application. This form could address the components mentioned above and would allow teachers to network and share their reviews of touchscreen applications, thus creating an efficient way for teachers to select quality applications.

Teachers play an important role in the planning and implementing the activities involving the use of touchscreen devices; however, they are not the only stakeholders. School districts and policy makers must also be aware of the research implications for touchscreen use in the classroom.

Implications for Educational Policy

The findings of this review attest to the benefit of using touchscreen devices as teaching and learning tools in the classroom. Schools must have adequate funding available to purchase touchscreen devices and applications. Funding must also be allocated for ongoing professional development addressing best practices related to the use of these devices.

Sifting through the copiousness of available touchscreen applications could be a daunting task for a classroom teacher. Schools and Area Education Agencies might consider employing specialized technology personnel to provide classroom support and resources for teachers. These individuals could also facilitate professional learning opportunities pertaining to the use of touchscreen devices, and the selection of quality touchscreen applications.

This review analyzes and synthesizes the most relevant and current research related to the use of touchscreen devices to support handwriting development of

preschool students; however, there are implications for future research. Additional research could reinforce the aforementioned recommendations and could also provide additional insights for educators.

Implications For Future Research

More research related specifically to preschool students is needed. It would be helpful to review research about specific touchscreen applications and curricula that are intended to support the handwriting development of preschool children such as *Handwriting Without Tears*.

With touchscreen use, children are using their hand muscles in different ways than traditional crayons and paper. There is limited research pertaining to touchscreen use written from the perspective of an occupational therapist. Studies related to how touchscreen use impacts the fine motor development of young children could provide additional insights.

As touchscreen devices are becoming more widely used by children and adults, it is important for research to consider the experience level of participants. Many of the studies analyzed in this review included children who had little or no experience with touchscreen devices prior to the study. Finding participants such as these would be increasingly difficult for researchers, due to the prevalence of touchscreen devices in our society. Future studies related to the use of touchscreen devices to support the handwriting development of preschool children, should make provisions for the touchscreen interaction skills that children possess before even entering preschool.

While this review describes many fine motor and cognitive benefits to using touchscreen devices to support the handwriting development of preschool children, teachers must be intentional in their use. Following the recommendations of this review when selecting touchscreen device activities and applications will ensure that teachers optimize the time that students spend using touchscreen devices in the classroom.

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