KEYBOARDING WITHOUT TEARS TO IMPROVE

THE KEYBOARDING SKILLS OF ELEMENTARY STUDENTS

By

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Abstract

In order to meet the demands of the technology-driven world, students must demonstrate keyboarding competency as early as in kindergarten. Common Core Standards now have technology requirement starting with third grade students having to compose work using a word processor. New advances in technology are adapting the classroom environment and involving technology for computer based test, assignments, and projects. Research supports keyboarding competency requires formal instruction however type and frequency is yet to be established (Freeman et al., 2005).   Keyboarding Without Tears ® (KWT) is a web-based application that utilizes game-based lessons to encourage the development of pre-keyboarding skills. KWT is unique in its approach to providing developmentally appropriate keyboarding education per grade level with consistent approaches to letter location and motor patterns (Olsen & Knapton, 2015).

The following research study examines the effect of KWT application on elementary students' keyboarding abilities compared to students receiving traditional keyboarding for a full academic year. Specific keyboarding abilities include speed and accuracy as well as

keyboarding method. Researchers also examine the relationship between time spent using the

KWT and improvement in keyboarding abilities.

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CHAPTER 1: Introduction

Students that have difficulty handwriting and keyboarding may be facing challenges meeting the demand of a technology-laden classroom. Students struggling with handwriting development often have difficulty completing classroom assignments and may avoid academic tasks all together (Cahil, 2009; Freeman, Mackinnon, & Miller, 2005). Personal desktop and laptop computers are often used in the classroom as a solution to handwriting barriers. However, these adaptations require a different skillset and motor abilities in order for keyboarding to be a more efficient method to handwriting. Additionally, current technology relies on keyboarding proficiency to operate and communicate on devices like cell phones, tablets, and laptops. Educators are also beginning to incorporate more computer-based activities into the classroom setting through online textbooks, assignments, and testing as a result of the budding technology. Modernizing the classroom is a rapidly growing trend, requiring students to develop keyboarding skills at a faster rate than ever before. One classroom intervention, Keyboarding Without Tears® (KWT), is a developmentally-based, student led keyboarding instructional application intended to foster keyboarding skills for grades K-5 (Olsen & Knapton, 2015).

Educators are searching for evidence to support the most effective method for providing keyboarding instruction to the students. Research suggests the importance of keyboarding instruction for the acquisition of keyboarding skills; however, more research should pursue the effectiveness of specific keyboarding programs to increase applicability (Freeman et al., 2005). A more detailed discussion of the gaps in the literature surrounding keyboarding interventions and keyboarding norms is to follow in Chapter 2 of this document. Therapists recommending KWT as an alternative for students with handwriting difficulties want to ensure students will be successful with this strategy. Additional research will contribute to the field of keyboarding

instruction, and provide evidence supporting Keyboarding Without Tears to be an effective classroom intervention that helps students develop essential keyboarding skills.

Problem Statement

In order to develop keyboarding competency, students require instruction to learn the motor sequences of pressing the keys as well as sufficient practice to habituate the motor patterns (Freeman et al., 2005). Educators providing keyboarding instruction as well as occupational therapy practitioners working with students supplementing keyboarding for handwriting difficulties will benefit from a reliable keyboarding application proven to be a successful tool for teaching keyboarding competency. However, there is limited research supporting specific keyboarding instructional programs for teachers and occupational therapists to implement that are available for grades K-5. The present study will compare the effects of a developmentally-based keyboarding application, Keyboarding Without Tears® (KWT), on students keyboarding in grades K-5 to a control school completing traditional keyboarding activities. A separate investigation will further compare the association between activities completed during the keyboarding intervention and the students keyboarding abilities for grades K-5. Additional detail of how these questions are addressed will be discussed in Chapter 3. By understanding the effectiveness of a specific keyboarding instructional application and the relationship between time invested into the application, as measured by activities completed, and keyboarding abilities; results of the intervention can be shared with educators, occupational therapists, and parents to develop keyboarding skills in students.

Purpose of the Study

The purpose of this research was to examine the change in keyboarding speed and method for students that received the KWT intervention compared to the students receiving

traditional keyboarding instruction to determine the most effective form of keyboarding instruction. Results of this study will contribute to the field of keyboarding instruction by establishing evidence based research supporting KWT as a tool for developing students' keyboarding speed and method. With additional research, investigators can hope to establish an effective keyboarding intervention for developing students' keyboarding abilities in order to meet the current technological demands of the classroom. This may also contribute to the development and standardization of keyboarding assessment for future keyboarding research explorations. Subsequent chapters have been prepared to explain in great detail the literature surrounding keyboarding research, the implementation of the research study, the results, and a discussion of the findings.

CHAPTER 2: Literature Review

Written and Typed Communication

Communication is an important skill for children to acquire in order to fulfill the occupation of a student. The two most common methods of written communication for a student include handwriting and keyboarding. Students not competent in these areas of performance, may face challenges composing pieces of work, which will negatively affect student's grades and self-esteem (Stevenson & Just, 2014). Both forms of communication produce written language through motor sequences that match orthographic codes, and require tactile perception and kinesthetic ability (Preminger, Weiss, & Weintraub, 2004). They are also similar in that they both require cognitive and motor demands and simultaneous fine motor control (Freeman, Mackinnon, & Miller, 2005). However, handwriting and keyboarding are two different modes of communication that require education of different skill sets and tool usage.

Mangen and Velay (2010) propose three main disparities between hand writing and keyboarding. First, handwriting requires predominantly one hand whereas keyboarding involves the coordination of both hands equally. Typically, unimanual operations result in a slower writing process generating more time for information processing (Perez Alonso, 2015). Skilled keyboarders type at a faster rate, which decreases the amount of time spent retaining information. The second difference is visual attention in relation to the motor component. Writing with a pencil and paper requires visual attention be directed towards the tip of the pencil and movement is provided to the pencil to direct the tip. However for keyboarding, visual attention is directed towards the screen and is separated from the motor component on the keyboard. Any separation in visual fields may diminish the quality or amount of devoted attention (Perez Alonso, 2015). Synchronizing visual and motor components of keyboarding may enable the writer to compose

or copy work with more ease. The third difference involves letter formation; handwriting requires graphomotorrically forming each letter, whereas keyboarding entails searching and selecting a letter on the keyboard (Cahill, 2009; Mangen & Velay, 2010). Both communication processes require different kinesthetic abilities and involve distinct cognitive, visual, and physical mechanics to produce work.

Handwriting is a refined skill that may support academic achievement even if it is not being used as a main source of communication (Cahill, 2009). This skill requires motor planning, visual-motor integration, visual memory, and cognitive processing (Christensen, 2004; Rogers & Case-Smith, 2002). Cognition is required to learn and recall the letter forms, the motor planning abilities to write down the letters, and fine motor skills to match the correct forms. In a 2012 study involving 15 children, researchers found students that practiced self-generated printing, or handwriting, demonstrated better letter perception in a reading task (James & Engelhardt, 2012). These findings imply handwriting is fundamental for developing important cognitive processes, like letter recognition, to help facilitate reading comprehension. Kinesthesia, or motor memory, refines finger and pencil movement during letter formation and controls the amount and direction of pressure applied to the instrument (Preminger et al., 2004; Stevenson & Just, 2014). This multi-skilled task requires mastery in several areas of performance, and may be difficult for students to become proficient in at a young age, especially students with fine motor challenges or learning disabilities. Handwriting difficulties have been linked to lower academic performance, and limited participation in school activities (Preminger et al., 2004). Keyboarding may be introduced as a compensatory strategy to be used in the classroom to improve participation and student success.

There are many advantages linked to the use of word processors including ease of editing, legibility, greater motivation, and increased amount of word production (Freeman et al., 2005; Rogers & Case-Smith, 2002; Stevenson & Just, 2014). Errors may occur with keyboarding, but they typically do not affect the legibility of the composition. Rather, keyboarding errors involve spacing or incorrect letter usage (Rogers & Case-Smith, 2002). Students keyboarding may have more stamina and can type for longer amounts of time compared to handwriting (Hoot, 1986; Rogers & Case-Smith, 2002). Pushing keys on a keyboard require less energy expenditure than writing using a pencil and paper. Research that compared keyboarding and handwriting found handwriting to be a more fatiguing method of copying four paragraph long passages when compared to typing (Brown, 1988). Subjects completing the handwriting copying task would stop and massage or stretch their writing hand, and in contrast, did not demonstrate any signs of fatigue after the keyboarding copying task.

Since keyboarding is a less tedious method for producing written work, students focus on the content of their work rather than the mechanics and motor requirement of handwriting (Barkaoui, 2014; Freeman et al., 2005; Hoot, 1986; Rogers & Case-Smith, 2002). Thirty-five, thirteen-year-old children with low orthographic-motor integration demonstrated improved creativity, originality, and quality when producing typed text compared to written text (Christensen, 2004). This may only be attainable if students are familiar with the keys and are proficient in keyboarding. Keyboarding is skill that involves language, cognitive, sensory, and motor capacities (Freeman et al., 2005). Preminger and colleagues found that keyboarding had a significant correlation with bilateral coordination, kinesthesia, and memory functions (2004). Skillful keyboarding requires knowledge of the keyboard and keys, as well as fine motor control to direct fingers to keys. In the beginning, students may rely on visual cues to locate and select

each key. However, skilled typists should be able to manipulate the keys only relying on the kinesthetic feedback of the learned motor processes (Freeman et al., 2005). Students should become experienced enough to internalize the location of the keys and understand the correct hand movements required to navigate from key to key over time with keyboarding practice. In fact, if students are not adept in keyboarding, they might spend more time searching for the keys and less time invested in producing work (Cahill, 2009; Preminger et al., 2004).

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Keyboarding Skills in Elementary School

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Education

   With increasing numbers of computers available in the classroom as well as inside the home, keyboarding is becoming an accessible option for students of all capabilities. School curriculums are incorporating more assignments and projects that require the use of keyboarding skills, thus making keyboarding competency more necessary than ever before (Barkaoui, 2014; Rogers & Case-Smith, 2002). In Freeman, Mackinnon, and Miller's (2005) literature review on keyboarding for students struggling with handwriting, they concluded that appropriate keyboarding education is crucial in developing proficiency in addition to providing opportunities to practice keyboarding once the skill was acquired. Providing computers or keyboarding software to students struggling with handwriting may not be an effective enough alternative. Unfamiliarity with the keys on the board can make keyboarding a long strenuous process (Freeman et al., 2005; Hoot, 1986). Furthermore, poor keyboarding skills can detract student's attention from the composition of the literature and instead directed to the motor process of finding and pressing keys (Barkaoui, 2014). Keyboarding education is essential for classrooms implementing computers as a learning tool for students using keyboarding as an alternative to handwriting.

It is important to determine an age at which students are developmentally ready to benefit from receiving keyboarding instruction, and what skills should be introduced at what ages. Research inconsistently supports recommendations for when to provide keyboarding instruction per grade level (Freeman et al., 2005). The nature and design of the keyboard instruction depends on the age level to which it is presented. Students as young as pre-school and kindergarten are showing adeptness to keyboarding. In a study of 525 kindergarten through third grade students, younger students were shown to have developed touch typing competence with minimal formal instruction (Hoot, 1986). Cowles, Hedley, and Robinson (1983) observed that young students, five to six years old, were able to type words correctly with little frustration after receiving a "Touch to Type Typing Program". Britten (1988) investigated 22 second graders, who received keyboarding instruction three times a week for twenty minutes per session, who exhibited significantly faster keyboarding abilities than the students that did not receive instruction. These results are supported by a pilot study performed by Chwirka and associates (2002) on sixty-six second grade students that also participated in a keyboarding program. Findings show that students receiving keyboarding instruction demonstrated significantly greater improvements in their keyboarding scores than the control group that did not participate. These studies suggest benefits to introducing touch-keyboarding instruction at a younger age, because these students have potential to develop the higher-level keyboarding style.

In contrast to the above findings, some research suggests that although younger students are developmentally ready for keyboarding lessons, they require more time and supervision making instruction less practical. Pisha's (1993) study on students in grades third through sixth found that older students developed keyboarding abilities at a faster rate than the younger students. Nichols' (1995) comparison of two keyboarding teaching methods on students in

grades third through sixth, indicated that students in the third-grade were able to improve keyboarding abilities from keyboarding lesson; however, it was more of a challenge to keep them engaged and focused than the older grades. A thorough review of the literature suggests that introducing keyboarding instruction during the upper elementary grade is an advantageous time for skill acquisition (Freeman et al., 2005). At this age, students are able to develop keyboarding skills in an appropriate amount of time. However, research also proposes that students as young as five or six are able to develop fundamental keyboarding skills with proper keyboarding instruction.

The National Educational Technology Standards (NETS) recommend kindergarten, first grade, and second grade students should have a basic awareness of computer operations (Roger, Laehn, Lang, O'Leary & Somers, 2001). It is also suggested that instead of recommending a specific grade level, keyboarding should be introduced prior to the grade level when computers are used for academic work (Freeman et al., 2005; Kisner, 1984). According to the Common Core State Standards (CCSS) (2016) keyboarding is first required in the writing standards for third grade when stated, "With guidance and support from adults, use technology to produce and publish writing (using keyboarding skills) as well as to interact and collaborate with others" (p.21). Fourth grade students writing standards involve, "With some guidance and support from adults, use technology, including the Internet, to produce and publish writing as well as to interact and collaborate with others; demonstrate sufficient command of keyboarding skills to type a minimum of one page in a single sitting" (Common Core State Standards [CCSS], 2016, p. 21). Fifth grade students are held at the same standard, except are expected to complete a minimum of two pages instead of one (CCSS, 2016). Kindergarten through third grade writing standards remain unclear regarding keyboarding usage, and require the use of a digital tool to

produce writings (CCSS, 2016). CCSS standards suggest the importance of introducing

keyboarding instruction at least by the third-grade level, if not sooner, to begin introduction to

digital tool use.

The International Society for Technology in Education (ISTE) Standards additionally

developed guidelines that enable educators to prepare students to perform at a level necessary to

be successful in the rapidly advancing technological period. The seven standards include:

Empowered Learner, Digital Citizen, Knowledge Constructors, Innovative Designer,

Computational Thinker, Creative Communicator, and Global Collaborator (ISTE, 2016).

According to the ISTE Standard 1.d. Empowered learner, students should have an understanding

of the fundamental concepts of technology operations including how to use devices and basic

knowledge of software applications (ISTE, 2016). This standard involves students using

technology to become more self-sufficient in setting and achieving learning goals. Standard 6,

the Creative Communicator states students should be able to clearly communicate and expressive

themselves in a creative way through digital media. More specifically, section 6.b requires

students to create original works or responsibly repurpose digital resources into new creations

(ISTE, 2016). These standards for students require computer competency and keyboarding skill

for composing and creatively expressing ideas on the computer.

In addition to age of introduction to keyboarding, a standard for hours keyboarding

instruction also remains uncertain. Earlier keyboarding studies employed keyboard instruction

that ranged from lasting five hours up to thirty total hours with a mean of 12.8 hours (Freeman et

al., 2005). Nichols' (1995) study implemented two types of keyboarding programs once a week,

thirty minutes a week, for either twelve weeks or an average twenty-one weeks at an elementary

school. Although the study was comparing two different types of keyboarding programs, the

researcher found greater keyboarding speeds for the twenty-one-week program overall (Nichols, 1995). Variance in keyboarding speeds may also be attributed to the method of keyboarding instruction; however, increased time spent during instruction has shown to impact the development of keyboarding skills. A review of keyboarding instruction noted the length of keyboarding education sessions typically lasting from 20-to-45 minutes meeting between two to five times per week (Freeman et al., 2005). With limited research to support the claim, Freeman and associates (2005) concluded that twenty-five to thirty total hours of instruction was the typical recommended amount. Overall, it is evident that keyboarding education is necessary for developing keyboarding competency so students can meet the technological demands in the classroom. However, more research will contribute to age of introduce and length of time to be invested in instruction.

Speed

When determining a student's fitness to type, his or her handwriting speed and initial keyboarding speed should be predictors of whether keyboarding may be a feasible adaptation to handwriting (Preminger et al., 2004). Students that struggle meeting the demands of handwriting may experience similar difficulties adapting to keyboarding. These challenges may be associated with fine motor skills that were not developed from handwriting; that are unable to help facilitate keyboarding acquisition (Freeman et al., 2005). Motor learning skills acquired through handwriting can be translated to developing speed and accuracy in keyboarding. Research suggest students should resort to keyboarding only if handwriting is unable to match the demands of schoolwork (Cahill, 2009). In order for keyboarding to be a viable option to replace handwriting in the classroom, a student should be able to type as fast as he or she can handwrite (Freeman et al., 2005). Pisha (1993) determined that students who wrote quickly had developed

keyboarding skills at a faster rate than students who wrote slowly. Several other studies support

the relationship between keyboarding speed and handwriting speed in elementary students

(Preminger et al., 2004; Rogers & Case-Smith, 2002). Handwriting can be a predictor for

keyboarding performance, and students' handwriting and keyboarding speed equivalency

predicts a child's ability to type at a sufficient level. If a student is performing at an appropriate

level, the students will be able to produce meaningful assignments with less effort especially for

students with handwriting difficulties.

Dunn and Reay (1989) sampled fifty-two students between the ages of twelve through

thirteen, to observe the effects on students' compositions when keyboarding speeds were greater

than or equal to their handwriting. Students that had slower keyboarding speeds than

handwriting revealed poorer content when using keyboarding over handwriting, versus students

that had faster keyboarding speed and could produce work with greater content. When speed of

keyboarding equals speed of handwriting, keyboarding becomes more automatic and attention

can be directed to creating the narrative (Freeman et al., 2005). If students are keyboarding at a

level equal to handwriting speed, they may be able to detract attention from the mechanics of

keyboarding and focus more on the content of the production. Keyboarding can improve

student's written productivity, especially with meaningful practice of this skill. As students

develop keyboarding skills, they understand the paths and trajectories to use to access the right

keys with increased speed (Freeman et al., 2005). Students that are continually keyboarding and

applying these skills will be able to refine and turn the skills in to an automatic process (Weiglt

Marom & Weintraub, 2015).

A current keyboarding speed norm per grade or age level is difficult to determine,

because the grade of instruction level to reach targeted speeds has also not yet been determined

(Freeman et al., 2005). Rogers and Case-Smith (2002) found that sixth-grade students'

keyboarding speed after attending 30 keyboarding courses, improved to a keyboarding speed

mean of 14.9 words per minute (WPM) at a rate that was 5 WPM greater than handwriting

speeds. In Nichols' (1995) study of third through sixth grade students receiving two different

types of keyboarding instruction, results revealed the average scores per grade were 5.7 WPM

for third grade, 7.0 WPM for fourth grade, 9.1 WPM for fifth grade, and 10.6 WPM for the sixth

grade. Freeman and associates (2005) produced a keyboarding speed summary from a collection

of research measuring keyboarding speeds based on grade level. According to the review of

literature students in grades first through third were keyboarding at an average of 9 WPM. Third

graders could reach speeds up to 30 WPM. The literature review indicates a range for fourth

grade students to keyboard between speeds of 7.1 WPM to 30 WPM (Freeman et al., 2005).

Fifth grade students were keyboarding at an even broader range from 4.7 WPM to 70 WPM

(Freeman et al., 2005). Keyboarding speed trends in research is highly variable and difficult to

generalize. An overall trend in increasing speeds with increased grade level can be concluded;

however, keyboarding speed ranges are even more ambiguous for higher grade levels (Freeman

et al., 2005). Grade specific keyboarding speed research using consistent keyboard instruction,

computer and keyboard, and a reliable assessment measure will contribute to normalizing

keyboarding speed.

Keyboarding Method

As mentioned earlier, in order for keyboarding to be an effective alternative to

handwriting, a level of keyboarding proficiency is required. The more automatic the

keyboarding process, the more the individual can focus on content over mechanics. However,

the most effective method for teaching keyboarding skills often debated in research (Freeman et

al., 2005). The most primitive keyboarding method is known in literature as 'hunt and peck'

where the individual locates each key through sight and utilizes one to two fingers to depress the

keys (Hoot, 1986). Hunting and pecking involves the use of one finger on one hand, to search

and press keys. The individual may also hunt and peck by using one finger on each hand that

requires more skill than a single hand hunt and peck. While this may not appear to be the most

efficient way of keyboarding, it can be a functional method for beginners or students with fine

motor challenges. A qualitative study on fifteen adolescents with fine and gross motor

challenges actually benefited from the 'hunt and peck' method, because it was a more functional

way of keyboarding (Niles-Campbell, Tam, Mays, & Skidmore, 2008). These individuals with

fine motor related issues were unable to coordinate fingers on either hand proficiently enough to

be successful with handwriting, and found and adapted keyboarding method to be both efficient

and less fatiguing. The 'hunt and peck' method has also been observed as advantageous in the

classroom for increasing speed of copying information. When compared to handwriting for

copying task, "two-finger" typing was found to be a faster alternative (Brown, 1988). However,

during this same comparison, the 'hunt and peck' method produced more errors due to the

amount of attention directed at the keyboard instead of on the document (Brown, 1988). The

hunt and peck method may be effective for producing short responses quickly, but not as

efficient for prolonged use with lengthy compositions. Overall this method is more time

consuming and difficult to correct once habituated (Kisner, 1984).

Although 'hunt and peck' can be more functional for some individuals than written

communication, keyboarding proficiency without visual feedback cannot be achieved through

this method. Evidence suggests 'touch-typing' may be a more automatic process than other

acquired methods (Freeman et al., 2005; Rogers & Case-Smith, 2002). Touch-typing, or touch

keyboarding, is the process that requires bimanual finger placement on the home row keys, and reliance on kinesthetic feedback for locating keys rather than visual (Freeman et al., 2005). Compared to the 'hunt and peck' method, touch-typing involves both hands and all fingers working synchronously to navigate and press the keys. Additionally, the shift from visual to kinesthetic feedback allows the individual to focus attention on the written work instead of the keys thus improving the content of the material (Freeman et al., 2005). Touch-typing becomes an automatic skill and frees up cognitive and visual processes, whereas hunt and peck detracts attention from planning compositions, visually tracking errors, and it disrupts the flow of the composition. Acquisition of touch-typing may be the most proficient way for producing quality work as well as meeting targeted keyboarding speeds.

It is currently presumed that touch keyboarding is associated with achieving keyboarding proficiency as measured through keyboarding speed, but there is little evidence supporting these assumptions (Hoot, 1986; Freeman et al., 2005). Touch keyboarding utilizes learned motor patterns to locate and press keys and relies more on muscle memory than visual feedback, which is why it is the preferred method for keyboarding instruction (Stevenson & Just, 2014). One study measuring keyboarding differences in students with autism spectrum disorder, found that students who were using a touch-typing method had a greater average keyboarding speed of 82.85 letters per minute than the students utilizing the hunt and peck method at 59.90 letters per minute (Ashburner, Ziviani, & Pennington, 2012). Unfortunately, students in the study did not receive standardized keyboarding instruction, so the results of the keyboarding methods do not support the most effective keyboarding method instruction. More research should be pursued to understand the benefits of keyboarding methods and at what age are higher-level keyboarding abilities able to be learned. One thing is for certain regarding keyboarding methods; introducing

proper keyboarding method from the beginning will prevent students from developing poor keyboarding tendencies that are difficult to amend (Freeman et al., 2005).

Motor Learning Theory

Keyboarding is a learned skill that involves the integration of visual and kinesthetic feedback for locating keys in a written production (Freeman et al., 2005). As students practice and become more proficient at keyboarding, they begin to rely less on the visual feedback and more on muscle memory to press the keys. This concept is known as motor learning, which is defined as, "a set of processes associated with practice or experience leading to relatively permanent changes in the capability for skilled movement" (Schmidt & Lee, 2011 p. 327). Keyboarding is a complex motor task that involves the internalization of motor sequences to in order to become efficient at 'touch-typing'. This style of keyboarding requires using both hands and fingers to follow an unconscious, kinesthetic motor pattern without depending on visual cues (Freeman et al., 2005). The acquisition of automatic keyboarding skills involves explicit instructions that are based on the principles of motor learning (Weiglt Marom & Weintraub, 2015). Motor skill habituation initially begins with relying on cognition and vision to influence motor performance. Eventually, this process leads to muscle memory of the motor pattern and self-corrections to increase precision (Stevenson & Just, 2014). Fitts and Posner (1967) outline this motor learning process into three stages consisting of cognitive, associative, and autonomous development.

First, the cognitive stage involves understanding the idea of the movement essential to complete a task, but not yet knowing how to replicate the movement (Zwicker & Harris, 2009). During this period, the learner is attempting to understand what strategies need to be done to complete a task. Effective strategies will be internalized and ineffective movements will be

discarded until the learner develops a pattern (Gillen, 2014). At this stage, performance on a skill is variable with many errors, because students are attempting different strategies (Gillen, 2014; Zwicker & Harris, 2009). In keyboarding, different movement patterns of the keys are being learned with visual feedback and remediation to initiate the acquisition process (Weiglt Marom & Weintraub, 2015). Using visual and kinesthetic feedback, students become more familiar with the keyboard. Once the skill has been learned, the learner enters the second stage for further refinement.

The second stage is known as the associative or retention stage, where the motor skills learned from the cognitive phase are refined and internalized (Gillen, 2014; Weiglt Marom & Weintraub, 2015; Zwicker & Harris, 2009). At this stage, the learner has determined the most effective strategy for producing a motor pattern, and now makes adjustments on task performance (Gillen, 2014). Keyboarding movement patterns will become more internalized at this point, and the individual begins to rely more on kinesthetic feedback than visual stimuli (Weiglt Marom & Weintraub, 2015). Practice has a large role at this stage, and in motor learning theory overall, for the refinement and improved consistency of keyboarding performance. Different types of practice have been observed to influence retention and transfer of motor patterns differently. Massed practice, practicing a task with little rest, or distributed practice, practicing a task with alternating periods of rest, are two methods for retaining motor tasks (Zwicker & Harris, 2009). Blocked practice, or repetitive practice on a task, is often associated with improved motor performance within a shorter amount of time, may not be the most effect method for fostering permanent motor skills (Zwicker & Harris, 2009). The greatest retention rates are associated with random practice, or varying task demands across repeated practice efforts (Zwicker & Harris, 2009). Random practice enables the students to develop skills

through exposure and promoting retention with an increased task demand. This concept is also known as the "just right" challenge involving variables of previous practice to be altered increasing the task difficulty (Cahill, 2009). Challenging tasks require students to employ learned motor task and adapt the skills to improve fluency. An additional practice component involves practicing tasks as a whole or in parts. During the beginning stages of motor learning, students may benefit from learning skills in parts and eventually incorporating the individual skills into a whole task (Zwicker & Harris, 2009). Using the learned and practice techniques, the students will work towards developing muscle memory for finger movement and placement associated with each key. This process of practicing tasks as parts then practicing as a whole helps learners develop skills under controlled conditions. Meaningful practice with challenging components promotes independent learning and increases generalization (Stevenson & Just, 2014; Zwicker & Harris, 2009). Eventually, with practice and exposure, the skill should become internalized and require little cognitive effort.

The final stage of motor learning, or the autonomous stage, involves performing a motor skill unconsciously relying solely on kinesthetic feedback (Weiglt Marom & Weintraub, 2015; Zwicker & Harris, 2009). In addition to requiring less vision for locating keys, students' typing speed and accuracy should increase with practice and muscle memory (Stevenson & Just, 2014). At this level the skill is automatic and can be performed with little distraction from other activities and even while engaging in other tasks (Gillen, 2014; Zwicker & Harris, 2009). Performance of this learned motor task requires less attentional demands, and can therefore divide attention to other activities. Individuals that have entered the autonomous stage will be able to type with minimum cognitive effort directed towards the keys (Weiglt Marom & Weintraub, 2015). Students that type at a functional level are able to invest more attention into

the thought process of the written production, and may ultimately become more successful in the classroom.

It is important to understand how students are able to develop keyboarding skills through motor learning theory in order to appreciate how a specific keyboarding application, like Keyboarding Without Tears**®,** utilizes these methods to ingrain keyboarding skills. Keyboarding Without Tears incorporates all three stages of motor learning to introduce, refine, and unconsciously perform the act of keyboarding.

Keyboarding Without Tears®

Touch-typing is taught using Keyboarding Without Tears® (KWT), a web-based application that teaches keyboarding and pre-keyboarding skills students need in order to be successful in the technology involved classroom. This application helps foster computer competency through developmentally appropriate game-based lessons that encourage keyboard acquisition in a fun and meaningful way for the child. KWT offers a 36-week curriculum designed for instruction in 5-10 minutes a day or 30 minutes a week, targeted for grades K-5. The application can be tailored to meet the time requirements of the teacher and the school. It is a self-directed, student-led application that also offers learning in pre-keyboarding and keyboarding skills based on the developmental needs of the student's grade level. As students progress through the application, they will be able to refine touch-typing abilities, as well as learn ways to safely navigate online and develop technology competency through teacher-led lessons. KWT offers developmentally appropriate keyboarding education per grade level, but the approach to letter location and finger movements are consistent through every age (Olsen & Knapton, 2015). This developmental approach is unique to KWT in that it enables students to move up through the application as they acquire grade-appropriate keyboarding skills. Most

studies involving keyboarding interventions utilize a single keyboarding program with no variation across grade levels (Freeman et al., 2005).

KWT color-coded keyboard is an important component and learning tool for the consistent reminder of motor patterns. A known factor support learning is presenting colors and animations to help learn and associate motor patterns (Arndt, 2016). KWT divides the keyboard into three color-coded rows to help the student become familiar with the location of the keys and direction of finger movements (Appendix A) (Olsen & Knapton, 2015). Yellow represents the top row and upward direction of finger movement from the home row keys, green represents the middle set of keys or home row, and blue represents the bottom row and downward direction of finger movement from the home row keys. Each row is divided into six units (top, home, bottom), three per hand, to facilitate acquisition of the keys (Olsen & Knapton, 2015). Students are expected to learn the rows unit by unit instead of being held accountable for learning the entire keyboard at one time. Kindergarten students develop unilateral hand skills first through activities involving the left and right hands independently. Separating the hand movements will help students better learn how to move fingers around the home row and prepares them to bimanual keyboarding. First and second grade students will then use both hands to complete games and activities that reinforce the basic keyboarding skills involved with forming letters and words. The tasks become more challenging in third through fifth grades, and the students develop competent keyboarding skills that are required for forming sentences and paragraphs (Olsen & Knapton, 2015). Students will be using the keyboard to develop skills that are needed to perform in the current classroom.

KWT breaks down activities and lessons per grade level to ensure appropriate content for lessons based on the developmental progression of keyboarding skills. Kindergarten uses the

'Keys for Me' application to introduce the keyboard and mouse functions to help the student develop pre-keyboarding skills (Keyboarding Without Tears, 2016; Olsen & Knapton, 2015). Activities are intended to support reading and handwriting with a focus on letter recognition, blends, digraphs, and rhymes (Olsen & Knapton, 2015). Appendix B depicts the kindergarten 36-week sequence of instruction that included the themes and activities per week that a teacher or school can choose to follow. First grade students will also use the 'Keys for Me' application to develop finger-key association for typing letters and words as well as drag-and-drop skills (Keyboarding Without Tears, 2016; Olsen & Knapton, 2015). At this level, students will be required to apply keyboarding skills through keying frequently used words and short sentences (Olsen & Knapton, 2015). Second grade builds off the previously learned skills and utilizes the 'Key Power' application to develop muscle memory utilizing the entire keyboard (Keyboarding Without Tears, 2016; Olsen & Knapton, 2015). Students at this grade will be expected to practice these skills through typing words and longer sentences at a higher difficulty level (Olsen & Knapton, 2015).

For the upper grades, third through fifth, the application changes from acquisition of skill to refinement of keyboarding abilities. Third grade involves refinement of skills in 'Keyboarding' application to sharpen accuracy and fluency of keyboarding abilities (Olsen & Knapton, 2015). At this level, students already understand basic keyboarding skills, and instead will work on formatting and typing paragraphs as well as strengthening fine motor memory (Keyboarding Without Tears, 2016). Similarly, the fourth-grade application implements 'Keyboarding Success' to also strengthen speed, fluency, and muscle memory. At this grade level, students will improve skills needed for computer-based testing and practice formatting documents (Keyboarding Without Tears, 2016; Olsen & Knapton, 2015). The last level, fifth

grade, involves the application 'Can-Do Keyboarding' to achieve mastery in accuracy and speed

to become keyboard competent in schoolwork and computer testing in higher grades. Student

will become proficient with formatting and keyboarding skills through writing sample

paragraphs on subjects that interest them (Keyboarding Without Tears, 2016; Olsen & Knapton,

2015). At the culmination of all six stages, students should have developed adequate

keyboarding skills that will allow them to be successful in the proceeding grade levels with

continual exposure and practice of keyboarding skills.

Every grade-level application contains Spot Checks along the way to measure students

understanding of skills through evaluating their speed and accuracy. Following the completion

of certain activities, students will be asked to take a Spot Check to assess their understanding of

skills they have been practicing. They have the option to take the speed and accuracy check up

to three times to beat their best score (Olsen & Knapton, 2015). This increases motivation while

ensuring they are putting in their best effort to earn a high score. Students are able to review

their results, and teachers will receive a data reports to track progress of every student as well

(Olsen & Knapton, 2015). Educators can monitor the student's comprehension of the specific

skills. Spot Checks measure speed in terms of letters per minute (LPM), words per minute

(WPM), and accuracy by percentage of correct keys hit (Olsen & Knapton, 2015). The Spot

Check assignments vary based on the grade level but they range from letters and words in

kindergarten to sentence and paragraph assessments in the fifth grade (Keyboarding Without

Tears, 2016). Varying the assessments per grade level prevents practice effects as well as helps

determine if the students are learning the skill taught in each application.

In addition to the keyboarding activities and spot checks, KWT also offers teacher-led

lessons to on technology and keyboarding (Olsen & Knapton, 2015). These grade specific

teaching guides offer activities and downloads to address digital citizenship, computer readiness, and finger placement (Keyboarding Without Tears, 2016). Different activities and curriculum are offered depending on the grade level. Digital Citizenship and literacy teaches important vocabulary regarding the parts of a computer, laptop, tablet, and other electronic devices (Olsen & Knapton, 2015). Students growing up in this digital age should be able to distinguish relevant trustworthy information from inappropriate or unreliable content on the computer (Arndt, 2016). KWT activities will help familiarize students to common technology terms and help maximize time spent on the computer. The four areas of Digital Citizenship include: digital information, digital protection, digital consideration, and digital communication (Olsen & Knapton, 2015). Ready, Set, Row: Getting ready to keyboard is a collection of activities that help the students become familiarized with the keyboard. Activities in this appliction teach students about correct finger placement and features of a keyboard (Olsen & Knapton, 2015). These activities provide students access to a keyboard through a hands-on approach. Consistent practice, instructions, and exposure over time will encourage students' understanding of a keyboard. Finger and Keys are additional supplemental activities that help promote finger and hand placement (Olsen & Knapton, 2015). This section utilizes songs, rhymes, and hand motions to help the students internalize key and finger placement. All three applications offer two versions of all educational material based on the student's grade level either K-2 or 3rd-5th (Olsen & Knapton, 2015). The teacher-led lessons and the online keyboarding instruction both offer activities involving kinesthetic movement to help develop keyboarding skills.

KWT is one of the first keyboarding applications to incorporate hand-on instruction, with developmentally appropriate activities, consistent exposure to movement sequences, and use different types of sensory stimulation to help foster keyboarding skills (Olsen & Knapton,

2015).   It is important to note that the use of the teacher-led lessons are optional. Although each grade level incorporates 1 teacher-led lesson per week in the teaching guidelines (Appendix B) (up to 36 lessons per grade), only 3 teacher-led lessons were used in the present study.

Summary

The purpose of this study is to conduct further research understanding the benefit of keyboarding instruction for elementary students. Keyboarding has been shown to be a meaningful occupation for students in a technology-rich classroom environment. Research supports the functional benefit of keyboarding over handwriting for students with handwriting difficulties as long as students are keyboarding at an equivalent speed or higher of handwriting abilities (Freeman et al., 2005; Rogers & Case-Smith, 2002). Keyboarding instruction is crucial for developing functional keyboarding skills; in fact, research suggests that without proper instruction keyboarding may be more of a hindrance (Freeman et al., 2005). When speed of keyboarding is equivalent to the speed of handwriting, students produce more work with improved content (Freeman et al., 2005). Studies have demonstrated the importance of keyboarding education (Freeman et al., 2005), the relationship between handwriting and keyboarding speed (Preminger et al., 2004; Rogers & Case-Smith, 2002), as well as the most effective keyboarding style (Ashburner, Ziviani, & Pennington, 2012), but little has been produced suggesting the most effective type of keyboarding instruction (Freeman et al., 2005). By understanding the effect of time spent educating on keyboarding abilities per grade level, keyboarding education can be replicated in classrooms, homes, and community centers to develop skills necessary for being a successful student.

Keyboarding Without Tears® is a gamed based, touch-typing, educational based computer application that teaches essential keyboarding skills (Olsen & Knapton, 2015). This

application is a viable classroom intervention and has both teacher-directed and student-led components to help the student best develop keyboarding skills based on developmental age of the child (Olsen & Knapton, 2015). This application, founded in motor learning theory, may enable students to acquire and internalize keyboarding skills through cognitive understanding of the keyboard, practice and exposure to the keys, and developing muscle memory (Zwicker & Harris, 2009). However, more research should be done to observe the effects of the KWT application on students' changed keyboarding performance, as measured by change in speed, after completing the 36-week application. Researchers hypothesize that students' receiving KWT instruction for an entire school year will demonstrate greater improvements in keyboarding speed and keyboarding method that compared to students receiving traditional keyboarding. Additionally, we hypothesize that amount of time spent using the application, as measured by KWT activities completed will correlate with improved net typing speed. By examining the overall effect the KWT application has on keyboarding performance, researchers will understand the best use for practice when implementing the KWT application. With this study, we can begin to understand the questions:

Is the improvement in keyboarding abilities (net typing speed and method of keyboarding) greater for students who have completed Keyboarding Without Tears® activities for keyboarding instruction than those who have completed traditional keyboarding activities (control)?

Is there a relationship between activities completed on the Keyboarding Without Tears® application and typing speed?

CHAPTER 3: Methodology

Design

This quasi-experimental, pre-test/post-test design examined the effectiveness of

Keyboarding Without Tears® application for students in grades Kindergarten through 5th. The

purpose of this study was to measure a change in keyboarding abilities (keyboarding speed and

keyboarding method) from the beginning to the end of the school year after using the KWT

application during the school year. The change in KWT students' scores on keyboarding speed

and keyboarding method assessments from pre-test to post-test was compared to the change in

scores of the students receiving traditional keyboarding instruction. At the completion of this

research study, all schools were offered KWT licenses for the following year as part of a larger

study.

Students

The inclusion criteria consisted of attending one of the four elementary schools

participating in the study in any grades kindergarten through fifth grade. Students were excluded

from the study if a parent/guardian elected to opt their student out. If the parents had chosen to

opt-out, his or her child's data would not be collected for use in the study; however, no student or

guardian elected to opt-out. Scores from the students that failed to meet the 20 percent of the

average completed keyboarding activities for their grade (See in Table 3.1) were excluded from

data analysis. Additionally, students that moved schools or students in the self-contained

classrooms were excluded from the study.

There were total of 2,307 students who participated in this study: 1,025 students from the

experimental schools, Madison Avenue Elementary (MAE) and Madison Upper Elementary

(MAUE) and 1,282 students from the control schools, Mannsdale Elementary (MAN) and

Mannsdale Upper Elementary (MANU). The first experimental school, MAE, offers

kindergarten through second grade and is located in Madison, Mississippi, a suburb north of

Jackson, Mississippi. They have approximately 486 enrolled students and have a diverse student

population (Madison Avenue Elementary, n.d.). MAUE, the second experimental school, is

within proximity to the lower school, and contains approximately 539 students grades third

through fifth (Madison Avenue Upper Elementary, n.d.). All students in both MAE and MAUE

schools participated in the KWT application in place of their traditional keyboarding instruction.

The control schools were chosen based on the recommendation of the administration who

advised researchers that MAN and MANU elementary schools were the most comparable to the

experimental schools based on proximity, geographical location, demographic representation,

annual household income, and grade levels. MAN Elementary is the first control school and has

approximately 612 students enrolled in kindergarten through second grade (Mannsdale

Elementary, n.d.). The second control school, much like the experimental, is located beside the

lower elementary school. MANU Elementary school offers grades third through fifth to

approximately 670 students (Mannsdale Upper Elementary, n.d.). Located in Madison,

Mississippi, these elementary schools share geographical proximity as the experimental schools

as all four public schools are in the Madison County School District. According to the 2016

population estimate, there are currently 105,114 residents in Madison County with the median

income being $64,376 and mean household income of $90,531 (United States Census Bureau,

2017). Madison County has the highest per capita income in the State of Mississippi compared

to the state median income of $39,665 and mean household income of $54,906 (United States

Census Bureau, 2017). The racial makeup of the county was 56.7% white, 38.2% African

America, 0.1% Native American, 2.3% Asian, 1.9% unspecified races, 2.8% Latino, and 0.7%

mixed race (United States Census Bureau, 2017). The demographic distribution of the four schools in comparison to the county can be found in Table 3.2.

Instrumentation

There are currently no standardized assessments that encompass both keyboarding speed and keyboarding method. Research utilizes two methods of measurement for assessing keyboarding skills acquisition: speed and accuracy as well as keyboarding method (Freeman et al., 2005). Five assessments were used in this study: 1) *Pre-test* and *Post-test Data forms* (Appendix C & Appendix D) 2) Keyboarding Method Observation 3) Keyboarding Speed and Accuracy test (Appendix E), 4) KWT Usage Data (Appendix F), and 5) School Records. The Keyboarding Method Observation, Keyboarding Speed and Accuracy tests, and KWT Usage Data were used as outcome measures for the research study. These assessment measures were established through research and selected based on the feedback from a pilot study conducted prior to this research study. The *Pre-test* and *Post-test Data forms* and School records were used for descriptive measures of the students.

Pre-test and Post-test Data Forms

Students completed the *Pre-test* and *Post-test Data forms* before and after completing the program, respectively, in order to gather demographics, prior keyboard experience, and technology usage information. The forms were coded using the students' lunch number to ensure confidentiality. Students completed the data form receiving help as needed to correctly and accurately answer the questions. Questions regarding demographic information involved indicating gender and handedness. Technology usage questions included checking boxes pertaining to general computer use and prior exposure to keyboarding instruction. Both data forms had three images of a laptop, a desktop, and a tablet for students to circle based on what

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they had access to at his or her home. There were additional questions regarding computer usage

at both home and school. One computer usage question on the data form was, "How often did

you use a computer at home during the summer?" (Appendix C). Students had four different

options to select to answer each question which include: every day, once a week, once a month,

or never. Finally, students were as to report if they had been previously taught keyboarding or

typing by circling either yes or no.

The *Post-test Data form*, administered at the end of the school year, followed the same

format as the *Pre-test Data form* and surveys demographic information, keyboarding usage, and

keyboarding method (Appendix D). The *Post-test Data form* was matched with the *Pre-test*

Data form based on the student's lunch number to detect changes in performance after

completing the application. In addition to the computer usage during the school year, the

students were asked four questions regarding their perception of the application. The questions

were: "Do you like the keyboarding activities you did in here?", "Did you look forward to doing

the keyboarding games?", "Do you think you are better at keyboarding now?", "Would you like

to do more keyboarding games?" Students had the option to circle either yes or no based on how

they felt about the keyboarding activities they completed during the school year. This

information contributed to the researchers' understanding of overall impression students had on

the efficacy of KWT application for the experimental students. Much like the pre-test, the *Post-*

test Data form had a section for researchers to report the keyboarding method observation. The

same scale used during the pre-test was utilized to observe changes in keyboarding styles to

measure the effectiveness of keyboarding instruction.

Keyboarding Method Observation

Keyboarding Method Observation was recorded at the bottom of the *Pre-test* and *Post-Test Data form* labeled "For researcher's use only". During the Keyboarding Speed and Accuracy tests for both pre-test and post-test, researchers recorded observations on the keyboarding method the students were using. The scale for recording keyboarding method ranged on a five point Likert scale (1) typing with one hand and one finger, and repeatedly using visual-feedback (i.e., visual guidance of keystrokes); (2) typing with two hands, using one finger in each hand, and repeatedly using visual-feedback; (3) typing with two hands, using two to four fingers in each hand, and repeatedly using visual-feedback; (4) typing with two hands, using all fingers of both hands, and repeatedly using visual-feedback; (5) typing with both hands, using all fingers, while looking at the monitor (and relying on kinesthetic feedback) (Weigelt Marom & Weintraub, 2015).

Keyboarding Speed and Accuracy test

The Keyboarding Speed and Accuracy test was completed through an online program, *Typing Test Pro*© at www.assesstyping.com. There were three portions of the Keyboarding Speed and Accuracy test including a warm-up and two timed paragraph copying keyboarding tests. Each Keyboarding Speed and Accuracy test involved copying a passage presented at the top half of the screen into a blank text box below the text (Appendix E). Students were instructed to copy the text from the passages by keying them as quickly and accurately as possible within the allotted time (Barkaoui, 2014). The assessment utilized a copying paragraph task to control for individual differences in spelling and written expression abilities to reduce effect of individual differences (Weigelt Marom & Weintraub, 2010). The warm-up was a 113-word long passage at a first-grade reading level where students had 60 seconds to type as much

as possible. The warm up was intended to reduce students' anxiety towards keyboarding thus

minimizing the experimenter effect. Next, students completed a 1-minute Keyboarding Speed

and Accuracy test (139 words), also at a first grade reading level, undergoing the same process as

the warm-up. Students then completed the 2-minute Keyboarding Speed and Accuracy test (209

words), only the paragraph was then a fourth-grade reading level (Appendix G). Students were

instructed to not attempt to go back to correct any mistakes and continue typing if a mistake has

been made, because the backspace key was disabled. Disabling the backspace function helped

researchers collect a more accurate gross and net word per minute calculation (Barkaoui, 2014).

Three calculations were made based on the results of the Keyboarding Speed and

Accuracy tests: gross typing speed, accuracy percentage, and net typing speed (Barkaoui,

2014). The gross typing speed represented the number of typed words per minute (WPM)

independent of typing errors (Barkaoui, 2014). Accuracy percentage is the percentage of words

typed correctly out of all the words that have been typed (Barkaoui, 2014). This percentage is

independent of the speed and amount of words typed. Net typing speed is the keyboarding

statistic that accounts for speed and accuracy, or the number of words keyed correctly (Barkaoui,

2014). This Keyboarding Speed and Accuracy test is supported by research utilizing net typing

speed and accuracy percentage to determine cut-offs for high typing speeds (Barkaoui,

2014). During post-testing, students re-took the Keyboarding Speed and Accuracy test to assess

changes in typing speed and accuracy.

KWT Usage Data

KWT application provided educators and the researchers with every student's data

through a program called +Live Insights. Activity counts were collected from this data set prior

to post-testing. The activity counts were used to approximate how often and at what capacity

students were using KWT in the classroom. +Live Insights was used to exclude students from the study that did not demonstrate enough participation by failing to finish at least 20% of the average completed keyboarding activities for their grade. In total, 34 students were excluded from this study based on their level of participation (see Table 3.1).

School Records

School records were obtained from the school administration to gather demographic information on the population of the students in the research study. Students were coded based on the assigned lunch number, to ensure confidentially. The information pertinent to this study that was collected includes gender, grade level, date of birth, race, and if the student qualified for special education.

<div align="center">

Procedure

</div>

Approval to conduct this full-year study was obtained from the East Carolina University's University & Medical Center Institutional Review Board (UMCIRB; Appendix H). Researchers also gained approval and a letter of support from school officials at Madison County schools (Appendix I). The principals at the experimental and control schools were contacted and informed on the KWT application and the prospective study. The benefit of the application, the contribution to research, and free KWT licenses were used as incentives for participation. All schools were provided information letters to be sent home with the students regarding KWT application during the first week of August 2016 (Appendix J & Appendix K). The information letter detailed research study and provided parents/guardians with the option to opt-out from participating in the study (Appendix L). The flyer also explained that the students will receive free annual KWT license during the year 2017-2018 for their

participation. The principal researcher's contact information was provided to direct potential questions regarding the requirements of the study.

The computer lab teachers at Madison Avenue Elementary and Madison Avenue Upper Elementary attended a 4-hour training session led by one of the researchers. The training session outlined the development of keyboarding skills, features of the KWT program (Teacher-led lessons, Spot Checks, etc.), and how educators can monitor the students' progress through +Live Insights. The teachers were also supplied with the three teacher-led lesson plans and the option to incorporate the lessons into the computer class. A sample teaching guideline for a kindergarten class is provided in Appendix B, but the teachers were not required to follow the lesson plans. The computer teachers at the control schools did not receive additional education on the KWT program or the research study.

Before beginning pre-testing, researchers completed an inter-rater reliability assignment to ensure consistent scoring of keyboarding method observations using the keyboarding method scale across researchers. The inter-rater determination involved watching 10 videos consisting of different keyboarding methods. Researchers were asked to score every video based on the five-point rating scale. In order to simulate the testing environment, raters were discouraged to pause or rewind the video to improve scoring accuracy. Each researcher's scores can be found in Table 3.3. Raters' responses were consistent and only off by one point for select videos. To ensure accuracy of rating, researchers met and discussed the five keyboarding ratings prior to pre-testing and post-testing.

Pre-testing

Researchers visited Madison Avenue Elementary and Madison Avenue Upper Elementary to begin pre-testing the week of August 15-19, 2016 and tested every available

student during regularly scheduled computer lab time. Refer to Table 3.4 for a timeline of assessments.

Students were asked to fill out the *Pre-test Data form* using pencil and paper with guidance from the researchers and teachers. Students were also asked to participate in the Keyboarding Speed and Accuracy test on the computer utilizing *Typing Test Pro* program. To initiate the Keyboarding Speed and Accuracy test, students, with help from researchers, teachers, or assistants, logged into the program by entering in an email and username. The email corresponded to his or her lunch number and school information (Appendix E). For example, if the student's lunch number was 123 and attended Madison Avenue Lower Elementary, the email address would be: "123@madionl.com". A username was also entered that corresponded with the students' grade and lunch number. *Typing Test Pro* additionally requested first and last name to complete the log in process. In order to maintain confidentiality and to help the researchers distinguish each grade level, the first name was the student's grade number and the last name was the student's lunch number. For example, if the student was in first grade and lunch number was 123, the first name will be "1" and the last name will be "123". Once the student was logged in to *Typing Test Pro* they were asked to complete a warm-up, a 1-minute, and a 2-minute timed Keyboarding Speed and Accuracy test. During this time, researchers were monitoring the classroom to assist students' transition to the next Keyboarding Speed and Accuracy test. Additionally, while students were completing the Keyboarding Speed and Accuracy tests, researchers walked around the classroom to observe and make note of the student's keyboarding method on the *Pre-test Data form.*

Pre-testing at Mannsdale Elementary and Manndsale Upper Elementary began the week of September 12-19, 2016. Researchers followed the same protocols for pre-testing at the

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experimental schools to ensure consistency across control and experimental groups. Only one of

the trained researchers who pre-tested at an experimental school was able to pre-test and score

keyboarding method for both control schools due to location and time constraints. Assistants

were recruited to help set up *Typing Test Pro* and help students fill out the *Pre-Test Data forms*;

however, only the trained researcher scored the keyboarding methods observation to ensure

accuracy and consistency in scoring. At the conclusion of the pre-testing period, researchers

entered the results from the *Pre-test Data form* and Keyboarding Speed and Accuracy test into a

SPSS file. To ensure accuracy of the data entry process, one researcher randomly selected 2

students from every class to confirm the results were entered correctly. When there was an error

with the data entered, the entire class was pulled and examined for accuracy.

Intervention

At the experimental schools, the KWT application was implemented for 24-29 weeks

during the students' weekly computer lab time, which was scheduled once a week. Amount of

time spent using the application varied based on class and grades. Kindergarten students were

scheduled for computer lab time for an hour, first and second grade students were scheduled to

receive fifty-minutes of computer lab, and third through fifth grade students were scheduled for

forty-five-minute sessions per week. Students were provided with the sample KWT keyboard at

the computer stations to further encourage retention of keyboarding movement (See Appendix

A). Students began KWT application the following weeks of computer class and continued the

application once a week for approximately 24-29 weeks. Researchers monitored student's

progress on +Live Insights and maintained contact with the computer lab teachers to ensure

consistent delivery of the KWT intervention any technical problems.

Students at the control schools received traditional keyboarding instruction during weekly computer class time, similar to the experimental school. Students in kindergarten through second grade attended computer lab once a week for thirty minutes a day. During this time, students played interactive games on the PBSkids website (www.PBSkids.org) that promoted mouse and keyboarding skills (Public Broadcasting Service, 2017). Kindergarten and first grade students played online games that taught mouse function and students learned to click and drag and other features of the mouse. Second grade students played computer games that promoted learning the keys to the keyboard and the strokes associated with keyboarding. Students in grades third through fifth grades attended computer lab once a week for forty-five minute class sessions. All three grade levels used Beginner Typing online typing lessons from Learn Typing© (http://www.learntyping.org) that teaches touch typing through structured activities, games, and tests (Holding, 2007). In addition to the online typing classes, students attended classroom lessons including topics on Microsoft power point, coding, and keyboarding strategies for touch typing. Students would often take speed typing tests online that measured keyboarding speed (WPM) and accuracy percentage (Groeber, 2017).

Post-testing

Near the end of the school year during the week of May 8-12, 2017 approximately 27 weeks into the program, researchers administered post-testing to all four schools. Using the same protocols for the pretesting, researchers administered the *Post-Test Data form* as well and the Keyboarding Speed and Accuracy test using *Typing Test Pro*. The post-testing took five days to administer to Madison Avenue Elementary, Madison Avenue Upper Elementary, Mannsdale Elementary, and Mannsdale Upper Elementary. At the conclusion of the research period, post-testing results were entered into the same SPSS file to run statistical analyses. All students were

sent home with an information sheet to debrief the students and guardians of the study and provide information on the continuance of the research study next year (Appendix J & Appendix K). Students that participated in the KWT application received a participation certificate with their name. Both Madison Avenue Elementary and Madison Avenue Upper, and Mannsdale Elementary and Mannsdale Upper Elementary schools will be offered KWT licenses for the following academic year for their participation in the study.

Ethical Issues

There were no ethical issues involved with this study. Before implementing the study, researchers obtained UMCIRB approval. The principals from both the experimental and control schools consented to participating in the study, and every participant had the option to decline participation. Students were coded by their lunch numbers, and all data files were secured in a locked file cabinet and electronic data was stored on the PirateDrive in order to protect the confidentiality of the students. Free KWT licenses will be provided for both experimental and control schools year to prevent withholding a beneficial intervention.

Data Analysis

At the conclusion of data collection, results of the assessments as well as the activity counts for the experimental school were entered into SPSS and analyzed using SPSS Version 22. The significance threshold was set at .05 for all analyses. Based on examining the visualizations and analyses of the data, results of the 1-minute Keyboarding Speed and Accuracy test demonstrated greater change when compared to results of the 2-minute Keyboarding Speed and Accuracy test. For improved clarity and fluency, only the results from the 1-minute Keyboarding Speed and Accuracy test will be reported in the manuscript. Results of the 2-

minute Keyboarding Speed and Accuracy test can be located in the appendix (See Appendices M-R).

Research question one examines the effect of the KWT application on both change in keyboarding speed and keyboarding method. To address the change in keyboarding speed for research questions one, box plots and scatter plots were generated depicting the change in net typing speed for every grade level. After reviewing the visualizations and checking for outliers, independent t-tests were performed for every grade level in order to determine a statistically significant difference in change in net typing speed on the Keyboarding Speed and Accuracy test. With the purpose of controlling for the main effect of KWT treatment for grade levels, a two-way analysis of variance (ANOVA) was then used to test if the mean changes on the 1-minute Keyboarding Speed and Accuracy test between the experimental and control schools are supported for grades third through fifth. The decision to control for grades third through fifth was based on the limited variation within the lower grade levels and did not significantly differ in relation to the KWT factor (See Table 4.1).

Next, to address the change in keyboarding method for question one segmented bar graphs were produced segmented by percentage of students that increased keyboarding method observation for every grade level. After reviewing the visualizations, contingency tables were produced to determine the odds ratio of improvement on keyboarding method observation score between the experimental schools and control schools. Fisher's exact test was generated to provide confidence intervals for the odds ratios.

Research question two examined the relationship between KWT activities completed on change in keyboarding speed. To address this question, scatterplots were generated depicting the relationship between KWT activities completed and change in net typing speed. After reviewing

the visualizations, a linear regression was performed to test the amount of variability explained

for every increase in KWT activities completed to the improved score on the Keyboarding Speed

and Accuracy test to determine the relationship between KWT activities completed and

improved keyboarding speed.

Tables

Table 3.1

Mean activity counts from KWT Usage data for determining exclusionary criteria for

experimental group

Grade	Mean Activity Count	N	Cutoff point (<20% average count)	Number of students eliminated
Kindergarten	176.6	165	35.32	7
First Grade	219.21	161	43.842	4
Second Grade	260.79	161	52.158	3
Third Grade	193.09	169	38.618	7
Fourth Grade	215.56	180	43.112	8
Fifth Grade	218.42	191	43.684	5
Total	213.80	1,027	35.32	34

Table 3.2

Demographic distribution

Descriptor	Experimental N=1025 N(%)	Control N=1282 N(%)	Total N=2307 N(%)	Madison County (%)
***Gender**: (Male)*				
Kindergarten	84(52.17)	97(54.50)	181(53.40)	
First	77(49.04)	118(56.73)	195(53.42)	
Second	95(58.64)	105(49.11)	200(53.05)	
Third	76(45.83)	122(55.71)	198(51.30)	
Fourth	103(56.91)	111(50)	214(53.10)	
Fifth	91(47.89)	105(48.39)	196(48.16)	
Grade:				
Kindergarten	162(15.8)	180(14.04)	342(14.8)	
First	160(15.61)	215(16.77)	375(16.3)	
Second	164(16.0)	217(16.92)	381(16.5)	
Third	167(16.29)	224(17.47)	391(16.9)	
Fourth	182(17.78)	224(17.47)	406(17.6)	
Fifth	190(18.54)	222(17.31)	412(17.9)	
Race:				
White	731(78.35)	799(76.02)	1530(77.1)	(56.7)
African American	122(13.07)	202(19.22)	324(16.3)	(38.2)
Hispanic	29(3.11)	16(1.52)	45(2.3)	(2.8)
Asian	50(5.36)	34(3.24)	84(4.2)	(2.3)
American Indian	1(0.11)	0(0.0)	1(0.1)	(0.1)
Special Education:				
Kindergarten	30(20.69)	14(11.0)	44(14.01)	
First	31(21.23)	24(13.95)	55(39.90)	
Second	18(12.68)	19(10.24)	37(11.25)	
Third	13(8.67)	12(6.78)	25(7.65)	
Fourth	15(8.93)	8(4.60)	23(6.42)	
Fifth	8(4.60)	15(9.31)	23(6.87)	

Table 3.3

Raters' scores from inter-rater reliability keyboarding videos

Video	Rater 1	Rater 2	Rater 3	Rater 4
1	5	5	5	5
2	4	4	4	3*
3	1	2*	1	1
4	1*	2	2	2
5	2	2	2	2
6	3	3	3	3
7	3	3	4*	3
8	1*	2	2	2
9	2	2	2	2
10	2*	3	3	3

= dissenting score

Table 3.4

Timeline of research between the months of August 2016 through May 2017

Week	Date	Event
Week 1	August 15th-19th 2016	Pre-testing at MAE and MAUE
Week 2	August 22nd-26th 2016	MAUE begin KWT
Week 3	August 29th-September 2nd 2016	MAE grades 1st and 2nd began KWT
Week 3-5	August 29th-September 16th 2016	MAE Kindergarten had computer testing & did not use KWT
Week 5-6	September 13th- 19th 2016	Pre-testing at MAN and MANU
Week 6-7	September 19th-30th 2016	MAE Kindergarten class began KWT
Week 7	September 26th-28th 2016	KWT delays for MAUE
Week 13-15	November 1st-18th 2016	MAUE 4th grade had rehearsal for school play instead of computer lab time
Week 16	November 21st-25th 2016	No class- Thanksgiving holiday
Week 20-22	December 19th 2016- January 3rd 2017	No class- Christmas break
Week 23	January 9th-13th 2017	MAUE and MAE took KWT Speed and Accuracy Assessment
Week 23-28	January 9th-Feburary 10th 2017	MAUE 3rd grade had rehearsal for school play instead of computer lab time
Week 32	March 13th-17th 2017	No class- Spring break
Week 35	April 3rd-7th 2017	MAE engaged in other classroom activities and did not use KWT
Week 36-37	April 10th-21st 2017	MAP Reading test for MAE 2nd and 1st grades, MKAS for kindergarten. KWT for students who completed testing
Week 36-37	April 14th-17th	No class-Easter
Week 39	May 1st-5th 2017	MAP reading testing for MAE Kindergarten. KWT for Students who completed testing.
Week 40	May 8th-12th 2017	Post-testing at MAE & MAUE Post-testing at MAN & MANU

CHAPTER 4: Results

Researchers' purpose was to examine the effectiveness of Keyboarding Without Tears® application on elementary students' keyboarding abilities (keyboarding speed and keyboarding method) compared to control schools using a traditional form of keyboarding instruction. Keyboarding abilities were measured by improvement in net typing speed (WPM) on the Keyboarding Speed and Accuracy test and improvement in keyboarding method on the 5-point Likert scale of Keyboarding Method Observation. Additionally, researchers sought to understand the effectiveness of the application by exploring the relationship between average amount of KWT activities completed at experimental school and students' change in net typing speed on the Keyboarding Speed and Accuracy Test.

Improvement in Keyboarding Speed and Accuracy

Visualizations. Several box plots were generated depicting pre and posttest net typing speed (See Appendix S) and change (post-test minus pre-test) in net typing spend on the Keyboarding Speed and Accuracy test for every grade level and for every experimental and control schools (See Figure 4.1). After reviewing the visualizations, outlying data points were highlighted and doubled checked to determine if they were entered in by error. No subjects were excluded.

Scatter plots were generated depicting the pretest to posttest net typing speed on the Keyboarding Speed and Accuracy test for every grade level to depict the trend (see Figure 4.2). All plots contained several outliers, however, since the sample size is large, the effect of outliers on the distribution of data is controlled. Based on the examination of all visualizations, students at the experimental school, particularly grades third through fifth, showed greater improvement in net typing speed compared to the control schools.

Independent-Sample T-Tests. Change in net typing speed on the 1-minute Keyboarding Speed and Accuracy test was significantly greater for students in experimental compared to the control schools for the following grades: first (experimental M=1.45, SD=1.945; control M=0.50, SD=1.237) t(303)=5.172, p<0.001; third (experimental M=4.12, SD=2.558; control M=2.15, SD=3.570) t(309)=4.674, p<0.001; fourth (experimental M=4.94, SD=5.142; control M=2.55, SD=4.542) t(334)=4.522, p<0.001; and fifth (experimental M=4.98, SD=5.754; control M=2.89, SD=4.468); t(323)=3.661, p<0.001. Results show the students at the experimental schools had greater change in net typing speed for pre-test to post-test on the 1-minute Keyboarding Speed and Accuracy test, but no statistical difference exists between the experimental and control kindergarten and second grades. See Table 4.1 for the results from the t-tests as well as the 95% confidence interval for the difference in means.

Two-way ANOVA. Initially the two-way ANOVA was run with the interaction term quantify the effect of treatment across third through fifth grades. However, the interaction terms were not statistically significant, so the two-way ANOVA was re-run with just main effects. Results of the two-way ANOVA with grade level (third, fourth, and fifth) and KWT (experimental and control) revealed a main effect of grade, F(2, 968)=2.54, p=0.079, and KWT treatment, F(1, 968)=52.82, p<0.001. These results of the two-way ANOVA supported the statistical difference noted in the independent sample t-tests. Table 4.2 displays the KWT treatment effect on net typing speed for grades third through fifth in addition to the 95% confidence intervals.

Improvement in Keyboarding Method

Visualizations. To visualize changes in keyboarding method, the students were dichotomized into two groups: Improvement by at least one and No improvement or digression.

Side by side boxplots were generated to depict the overall trends in change of keyboarding method comparing experimental and control schools for every grade level (see Figure 4.3). Based on the visualizations, experimental grades kindergarten through second demonstrated greater improvement in keyboarding method, whereas control grades third through fifth exhibited greater improvement in keyboarding method.

  Two-Way Frequency Table. A Two-Way Frequency table was produced to determine if the change in keyboarding method observation scores between the experimental and control schools were statistically significant (see Table 4.3). The grades that demonstrated greater improvement in keyboarding method were experimental grades kindergarten (53.47%), first (74.13%), and second grade (84.06%); and control grades third (83.24%), fourth (79.57%), and fifth (58.18%). Results of the Fisher's Exact test indicated the odds of improved score for experimental grades kindergarten through second grade were approximately 25, 8, and 15 times than the control grades, respectively. Alternatively, for grades third through fifth the experimental school is less likely to improve, odds are approximately 0.4 times the control group for each of the grades. Difference in scores were statistically significant for all grade levels (p<0.001).

Relationship Between KWT Activities Completed and Keyboarding Speed

  Visualizations. Scatter plots comparing the relationship between KWT activities completed and change in net typing speed was produced to check for departures from the mean and variability (see Figure 4.4). The scatter plots depicted a roughly positive, linear association on both Keyboarding Speed and Accuracy tests without extreme outliers. Despite the weak linear shape of the relationship, the scatter plots met the assumptions for linear regression.

Linear regression. Several linear regressions were calculated to predict change in net typing speed on both Keyboarding Speed and Accuracy tests based on the amount of average KWT activities completed. Overall for the 1-minute Keyboarding Speed and Accuracy test, a significant regression equation was found ($F_{(1, 886)}= 38.298$, $p<0.001$), with an R^2 of 0.041. Students' predicted improvement in net typing speed was equal to $-0.290 + 0.015$ (time spent using KWT application) WPM when time spent using KWT application was measured in amount of completed KWT activities. Net typing speed increased 0.015 WPM for each KWT activity completed. The square of the regression line for the 1-minute Keyboarding Speed and Accuracy test demonstrates a great deal of variation from the regression line. Table 4.4 depicts the results of the linear regressions for the specific grade levels and Keyboarding Speed and Accuracy tests.

Tables

Table 4.1

Results of t-tests and Descriptive Statistics Change in Net Typing Speed on 1-minute Keyboarding Speed and Accuracy test by Treatment

Outcome	Group						95% CI for Mean Difference	t	df
	Experimental			Control					
	M	SD	n	M	SD	n			
Kindergarten	0.39	0.56	144	0.24	0.57	165	0.03, 0.28	2.37	307
First	1.45	1.95	143	0.50	1.24	162	0.59, 1.32	5.17*	303
Second	1.91	2.56	139	1.46	2.20	183	-0.07, 0.97	1.69	320
Third	4.12	3.85	144	2.15	3.57	167	1.14, 2.80	4.67*	309
Fourth	4.94	5.14	155	2.55	4.54	181	1.35, 3.43	4.52*	334
Fifth	4.98	5.75	163	2.89	4.47	162	0.97, 3.22	3.66*	323

* $p < 0.01$

Table 4.2

ANOVA Results and Descriptive Statistics for Changes in Net Typing Speed on 1-minute Keyboarding Speed and Accuracy test by KWT Treatment

Variable	M	SD	n
Experimental			461
Third	4.12	3.85	144
Fourth	4.94	5.14	155
Fifth	4.98	5.75	162
Control			510
Third	2.15	3.57	167
Fourth	2.55	4.54	181
Fifth	2.89	4.47	162

Source	SS	df	MS	F
Experimental vs Control	1124.54	1	1124.54	52.82*
Grade	108.27	2	54.14	2.54
Error	20608.02	968	21.29	

*$p<0.001$

Comparisons of Mean differences in Experimental and Control Schools by Grade for Net Typing Speed on 1-Minute Keyboarding Speed and Accuracy test

Comparison	Estimated Mean difference	Standard Error of Difference	t	95% Confidence Intervals
Experimental vs Control	2.16*	0.30	7.27	1.57, 2.74

*$p<0.05$

Table 4.3

Results of Two-Way Frequency tables Depicting Change in Keyboarding Method

Grade		Improvement (%)	No improvement (%)	Estimated Odds Ratio	95% CI	P-Value
Kindergarten	Experimental	77(53.47)	67(46.53)	25.29	10.95, 68.47	0.00
	Control	7(4.29)	156(95.71)			
First	Experimental	106(74.13)	37(25.87)	7.75	4.56, 13.45	0.00
	Control	44(26.83)	120(73.17)			
Second	Experimental	116(84.06)	22(15.94)	15.09	8.41, 28.07	0.00
	Control	47(25.68)	136(74.32)			
Third	Experimental	94(64.38)	52(35.62)	0.37	0.21, 0.63	0.00
	Control	144(83.24)	29(16.76)			
Fourth	Experimental	91(58.71)	64(41.29)	0.37	0.22, 0.61	0.00
	Control	148(79.57)	38(20.43)			
Fifth	Experimental	61(37.42)	102(62.58)	0.43	0.27, 0.69	0.00
	Control	96(58.18)	69(41.82)			

Table 4.4

Results of Linear Regression Predicting Changes in Net Typing Speed Based on Amount of KWT
Activities Completed for 1-minute Keyboarding Speed and Accuracy Test

Variables	N	R^2	B	95% CI	P
1-Minute Timed Typing Test	888	0.04	0.02	0.01, 0.02	0.00
Kindergarten	144	0.01	0.00	-0.00, 0.00	0.17
First	143	0.15	0.01	0.01,0.02	0.00
Second	139	0.09	0.01	0.01, 0.02	0.00
Third	144	0.11	0.05	0.03, 0.07	0.00
Fourth	155	0.03	0.16	0.00, 0.03	0.05
Fifth	163	0.12	0.04	0.02, 0.06	0.00
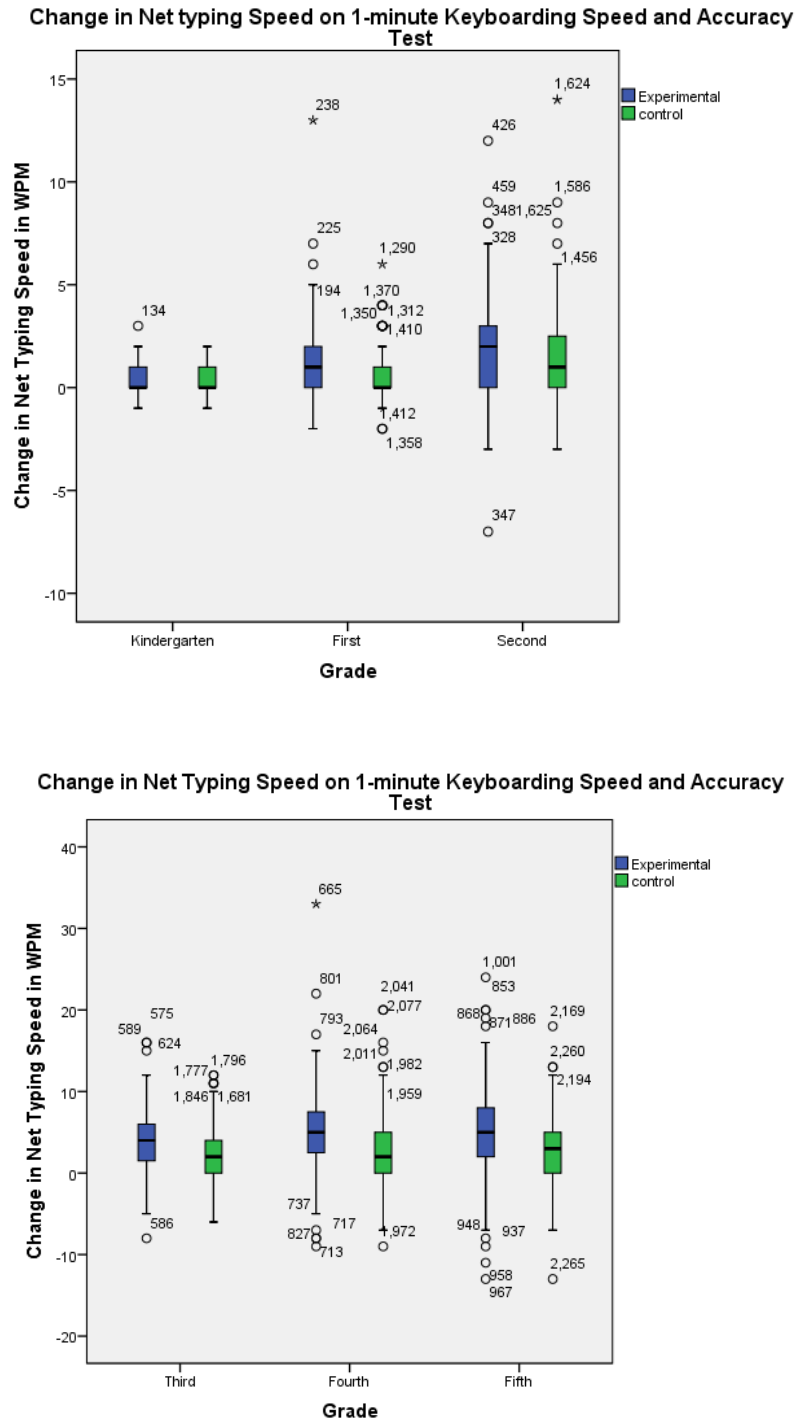
Figure 4.1. Change in Net typing Speed Box-plots. This figure illustrates the results of the change in pre-test and post-test scores for the 1-minute Keyboarding Speed and Accuracy tests.
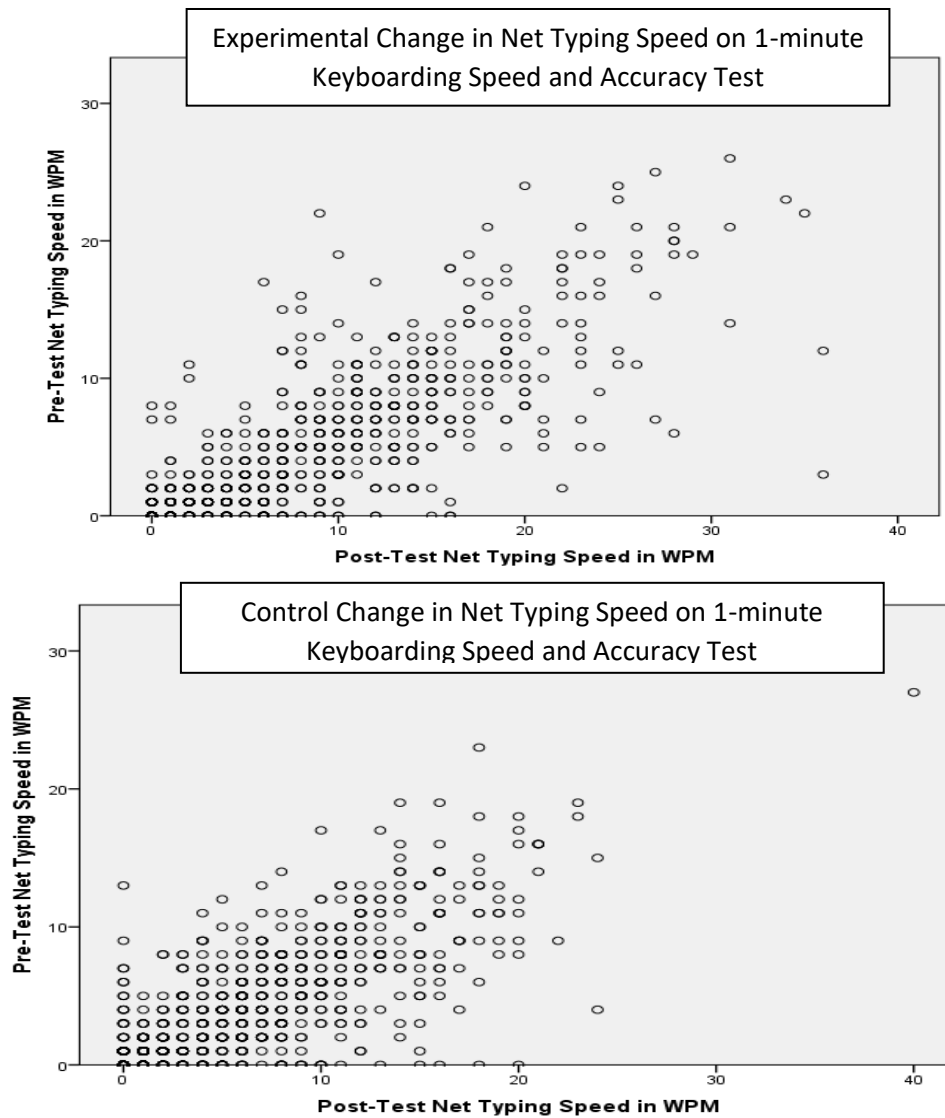
Figure 4.2. Change in Net typing Speed Scatter Plots. This figure illustrates the results of the change in pre-test and post-test scores for the 1-minute Keyboarding Speed and Accuracy tests.
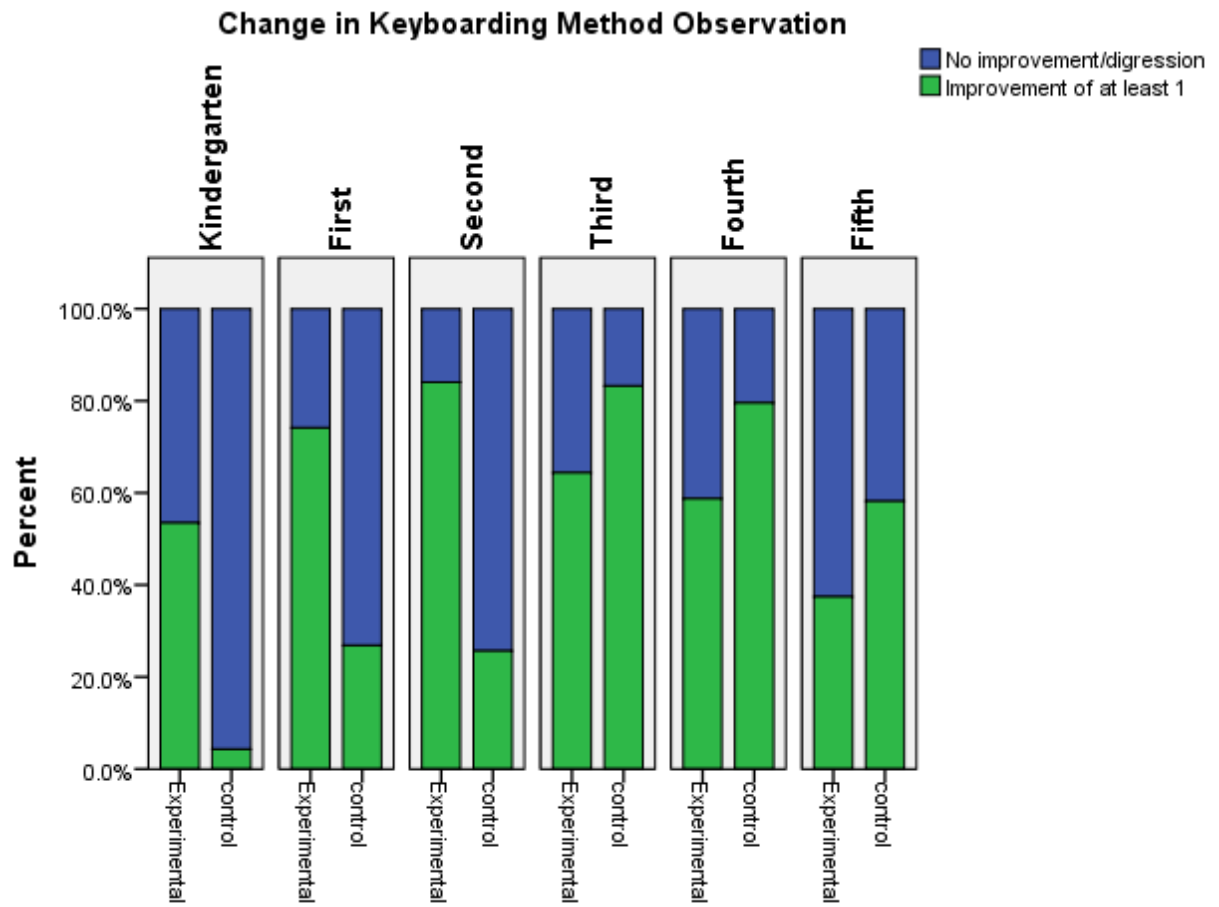
Figure 4.3. Change in Keyboarding Method. This figure illustrates the results of change in keyboarding method from pre-testing to post-testing.
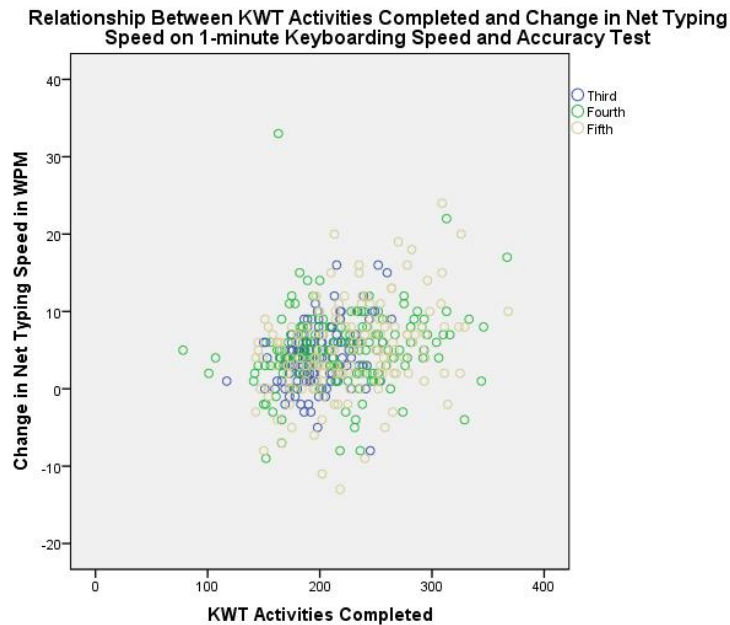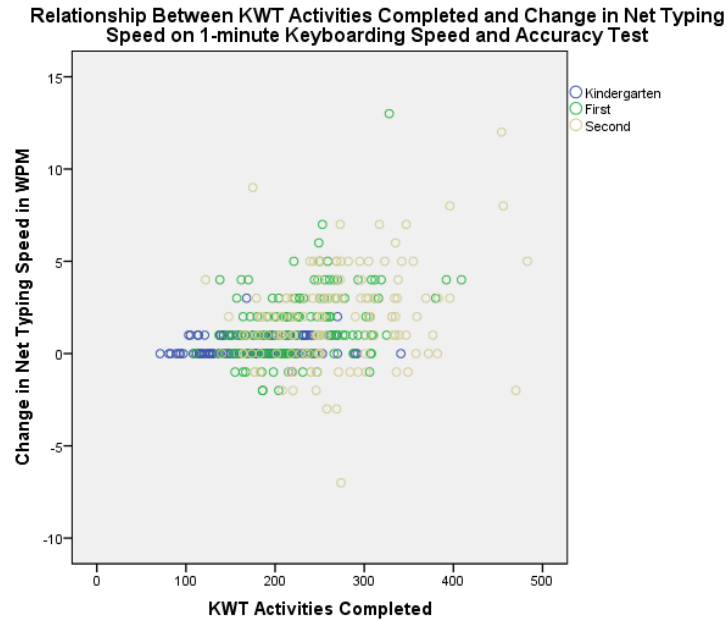
Figure 4.4. Relationship between KWT activities completed and change in Net typing speed scatter plots. This figure contains the scatter plots depicting the relationship between change in net typing speed and activities completed for the upper and lower experimental schools.

CHAPTER 5: Discussion

This present study sought to understand the impact of implementing a grade specific keyboarding application (experimental) in an elementary setting compared to traditional keyboarding instruction (control). Students' keyboarding performance was measured through net typing speed, which accounts for typing speed and accuracy, as well as keyboarding method. Comparisons were made between the experimental and control students' change in net typing speed and keyboarding method from pre-test to post-test. Researchers found significant differences in improvement of net typing speed on 1-minute Keyboarding Speed and Accuracy test between the experimental schools and control schools in grades of first, third, fourth, and fifth, with greater improvements in the experimental schools. The effect of KWT treatment on keyboarding speed was also confirmed in the two-way ANOVA at a statistically significant level for grades third through fifth ($p<0.001$). Students' keyboarding method for experimental grades kindergarten through second demonstrated significant differences in improvement from pre-test to post-test when compared to the control grades. The improvement in keyboarding method at the experimental school for grades kindergarten through second grade was statistically significant ($p<0.001$).

To further address the effect of the keyboarding intervention on the students' keyboarding speed, researchers recorded the amount of activities the students' completed to represent time spent on the application. The relationship between the amount of activities completed and improvement in net typing speed was visualized through scatter plots and analyzed using a linear regression. Results of these analyses indicated a weak, linear association for the 1-minute Keyboarding Speed and Accuracy test ($R^2 =0.041$).

<center>**Interpretation**</center>

Demographics

   The demographic distribution of the experimental and control schools revealed few differences between the schools. Gender, grade, and race distributions were equally represented in both schools (see Table 3.1). However, the experimental school had a greater representation of students in special education for grades kindergarten through fourth. Only students in self-contained classrooms were excluded from the study, and all other students in special education participated in the study and the KWT application. The uneven distribution of this population may have influenced the validity of the results; however, due to the large sample size, according to the central limit theorem, the variances should balance. In addition to special education, the ethnicity distribution was not representative of Madison County. The overall percentage of white students for both groups was (77.1%) compared to the county wide distribution of (56.7%) (United States Census Bureau, 2017). African American (16.3%) ethnicity was underrepresented in the study compared to the county population (38.2%) (United States Census Bureau, 2017). Discrepancies between the sample and total population impacts the generalizability of the results and replicability of the study on more diverse populations.

Instrumentation

   Typing Test Pro© was a convenient and effective testing instrument that produced a statistic accounting for both speed and accuracy to quantify keyboarding abilities. The typing test was a copying task to control for literacy difference among the students (Weigelt Marom & Weintraub, 2010). Unfortunately, the lower elementary schools, particularly at the beginning of the school year during pre-testing, faced challenges with letter identification. Although resolved by post-testing, kindergarten students especially had more of a challenge following directions

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and participating in the time typing tests. Further research incorporating grade specific typing tasks will contribute to the assessment of keyboarding abilities.

Keyboarding method observation measure was the five-point numerical assignment used to quantify students' current and improved keyboarding method. Since the keyboarding method observation is a subjective measure, researchers completed an inter-rater assessment and discussed discrepancies among the raters. Despite efforts to improve reliability of the assessment, human error and subjectivity is a limitation to this assessment.

Improvement in Keyboarding Speed and Accuracy

Results of the independent sample t-tests indicated significant differences in improvement in net typing speed from pre-test to post-test on the 1-minute Keyboarding Speed and Accuracy test between the experimental and control grades first, third, fourth, and fifth, with greater improvement in the experimental schools ($p<0.001$). Based on the 95% confidence interval, the true mean of the improvement in net typing speed exist within the following intervals in WPM: first grade (0.59, 1.32), third grade (1.14, 2.80), fourth grade (1.35, 3.43), and fifth grade (0.97, 3.22). Results of the two-way ANOVA further support both the clinical and statistical significance supporting the effect of KWT treatment significantly increases net typing speed compared to the control school for grades third through fifth ($p<0.001$). The true mean of improvement in net tying speed for the experimental grades third through fifth based on the 95% confidence interval exists within 2.28 WPM and 3.44 WPM. These findings support the benefit of introducing the KWT application to improve keyboarding speed. KWT is unique in its approach to providing consistent exposure to movement sequences and incorporating multiple forms of sensory stimulation to enhance carry over of learned keyboarding abilities (Olsen & Knapton, 2015). Sensory stimulation in the KWT application, not prevalent in the traditional

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keyboarding instructions at the control schools, encourages retention of keyboarding movements and strategies supported by the cognitive stage in the motor learning theory (Weiglt Marom & Weintraub, 2015).

In the upper control grades, students learned basics of touch typing through online videos and tutorials, speed typing tasks, as well as through incorporating math games. Experimental students were receiving consistent exposure to the KWT games with motivating and stimulating components to improve understanding of movement patterns. Additionally, consistent repetitive practice related to the associative stage in the motor learning theory, was also present in the structured delivery of the KWT application more so than the traditional keyboarding instruction. The KWT application provides repetitive exposure to motor patterns through the structured formatting of the application.

Kindergarten and second grade demonstrated improvement in the application however not at a significant level. These findings are supported by Pisha's (1993) study that found that older students developed keyboarding speed at a faster rate than younger students, and younger students required more instruction and supervision. Additionally, the lack of statistical significance may be attributed to the content of material KWT taught in kindergarten through second grade. Instruction for the earlier grades involves an introduction to the keyboard and mouse functions, developing finger-key associations, and muscle memory of the finger movement sequences (Olsen & Knapton, 2015). Towards the end of first and second grade KWT application, students are expected to compose frequently used words and sentences using the keyboard. It is not until the later grades that the KWT application places more of an emphasis on keyboarding fluency and refining the memory patterns (Olsen & Knapton, 2015). Students' with continued exposure to activities that refinement keyboarding motor sequences

should be keyboarding at a faster rate, because repeated practice contributes to internalizing skill. Continued research and participation in the KWT application will contribute to the effect of the KWT application on keyboarding abilities for lower grades.

Improvement in Keyboarding Method

The segmented bar graph and two-way frequency tables indicated experimental grades kindergarten through second grade demonstrated grater improvement in keyboarding method compared to their counterparts at the control school, whereas, the control grades third through fifth demonstrated greater improvement in keyboarding method compared to the experimental grades third through fifth. Incongruences between the upper and lower grades may be attributed to the educational content of KWT application and students' prior level of keyboarding performance and. The KWT application for the lower grades places more emphasis on hand placement, key location, with a thorough introduction to touch typing (Olsen & Knapton, 2015). KWT application for the upper grades provides more practice on word and sentence formation. Additionally, students in the upper grades were already keyboarding with an established keyboarding method and were less impressionable compared to the lower grades. Further research should be done to contribute to the use of KWT application as an effective intervention for learning touch typing and improving students' keyboarding method.

Relationship Between KWT Activities Completed and Keyboarding Speed

Based on the scatter plots depicting the scores on the Keyboarding Speed and Accuracy test and KWT activities completed, there was a weak, positive, linear relationship (see Figure 4.4). Results of the linear regression produced a small R-squared values (R^2=0.041) for 1-minute Keyboarding Speed and Accuracy test indicating high variability from the regression line (see Table 4.4). Students' participation on the activities and prior level of performance may influence

the validity of this analyses. Students' participation on the activities impacts his or her retention of the material in the application. Since the application is student-led, they have the option to advance through the application at his or her own pace. If a student wishes to progress through activities and not retain information then it would not be reflected in his or her performance on the Keyboarding Speed and Accuracy test. Furthermore, students' prior keyboarding performance may also be a confounding variable with the effect time spent on the application has on change in net typing speed. Additional research should be done to better understand the correlation between time spent on the KWT application and improvement in keyboarding abilities.

Limitations

There are several limitations to this study, the first being the sample of students at the experimental and control schools. Researchers attempted to collect students that were a better representation of the entire population for the study. However, the schools were selected based on convenience sampling, which decreased the generalization of our results to other populations. Due to the convenience selection of the schools, students were not randomly assigned to the control and experimental schools creating a selection bias. Additionally, our sample lacks diversity, because all schools are from a single geographic location. Even though this decreases the generalizability or external validity of the findings, this was the most convenient and efficient way to carry out the study.

Another limitation to the data collect was the influence of observer bias and personal interest since the researchers were not blinded to the study. The researchers' keyboarding method observations were potentially influenced by his or her knowledge of the experimental and control schools. High expectations of the students receiving the KWT treatment might have

led to an observed increase in keyboarding performance that did not actually exist. These factors could potentially influence the results and the validity of the data. However, blinding researchers would be impractical due to the training involved with researchers, coordinating testing schedules, and ensuring the students refrained from using language that suggests which group in the experimental group would not have been feasible. Instead researchers were instructed to remain impartial and were bonded by to his or her own moral and ethical responsibilities as a researcher.

Similarly, the presence of the Hawthorne effect from researchers being in the room was another limitation, as students may have improved their behavior as a result of being observed. Students' score on the keyboarding method observation might have been higher than their typical keyboarding method due to their increased awareness of participating in a study. These factors potentially affected the researchers' observations of the students' keyboarding skills, disguising the effect of the KWT application. Students were observed in a natural school environment surrounded by familiar peers and instructed by their computer teacher during their regularly scheduled class time to account for any treatment effect that may occur when participating in an unfamiliar educational program.

In order to minimize these limitations, researchers remained aware and impartial when conducting pretest and posttest assessments. The inter-rater reliability measure ensured that the researchers were accurately scoring the students. Students' keyboarding skills were also measured using other assessments like the Keyboarding Speed and Accuracy test. By gathering data from multiple resources, researchers were able to exactly measure the effect KWT has on keyboarding abilities.

Furthermore, the activities used as a measure of the student's participation in the KWT application was a final limitation to the study. The amount of time students spent per each KWT activity varied as did the challenge of each activity, the motivation to complete the activity, and the students' attention to the activity. Therefore, utilizing the amount of KWT activities completed as a proxy for time spent in the KWT application was not the most accurate measure. Future research should be done to better quantify time spent using the KWT application to examine the relationship between KWT and improvement in keyboarding speed.

Implications for Occupational Therapy

Establishing an effective keyboarding instruction can be a valuable educational tool utilized by occupational therapy practitioners to meet the demands of the evolving classroom. Occupational therapy practitioners may consider introducing keyboarding as an alternative to students experiencing hand writing difficulties (Ashburner, et al., 2012; Preminger et al., 2004). Once competent, students can communicate ideas more freely on word processors instead of becoming distracted by frustrations associated with handwriting difficulties (Rogers & Case-Smith, 2002). Moreover, the use of word processing has now become more accessible in classrooms due to the increasing numbers of computers available, and state common core standards are now implementing technology standards in the classroom starting with third grade (CCSS, 2016).

The current research study highlighted the effectiveness of KWT application through the comparison of students' keyboarding speed and keyboarding method with KWT compared to traditional keyboarding for an entire school year. Students in first, third, fourth, and fifth grades receiving KWT treatment effectively increased net typing speed significantly more compared to those who received traditional keyboarding instruction. Additionally, results of the study

indicate that students using KWT application in grades kindergarten through second demonstrated a greater improvement in keyboarding method than the traditional keyboarding instruction.

Recommendations for Future Research

Future research should be pursued to support the relationship between the KWT application and the impact on keyboarding abilities in the school setting. By expanding the sample to other regions, the sample population will become more diverse and increase the generalizability of the results. Additionally, future research may consider incorporating simple letter copying tasks more suitable for the lower grades to improve validity of the speed and accuracy assessments.

Conclusion

In conclusion, students' participation the KWT intervention demonstrated improvement in keyboarding skills when compared to students' receiving traditional keyboarding, supporting our initial research hypothesis. Strengths of the students' performance on the assessments were related to the grade specific content of the application. Experimental students in grades third through fifth revealed a significant improvement in net typing speed when compared to the control school. Furthermore, experimental students in grades kindergarten through second grade demonstrated significant improvements in keyboarding method when compared to the control lower elementary students coinciding with the instructional material taught in the KWT application. Despite the weak association between the KWT application with improvement in net typing speed, our second research hypothesis was not supported claiming there was a relationship between KWT activities completed and improvement in net typing speed. The

strength of the association was potentially influenced by extraneous variables including students' prior level of performance, participation in the application, and inconsistencies with types of activities completed.

Based on current research, there is considerable variety in recommendations for keyboarding instruction regarding type, frequency, age level, and duration of instruction (Freeman et al., 2005). Results of this present research study supports the work of previous research suggesting an early introduction to touch keyboarding using the "home row" keys (Hoot, 1986; Pisha, 1993). Students in lower elementary grades were able to demonstrate an understanding of touch-typing method after the first year of KWT. Additionally, findings from the current study support grade-specific keyboarding instruction designed to facilitate grade-appropriate keyboarding competency. The data suggests that the implementation of KWT in a school-based setting is an effective instrument for facilitating touch-typing in lower elementary grades and improving speed and accuracy in upper elementary grades when compared to traditional keyboarding instruction.

References

Arndt, P.A. (2016). Computer usage for learning how to read and write in primary school. *Trends in neuroscience and education*. 5, 90-98. Doi: 10.1016/j.tine.2016.07.003

Ashburner, J., Ziviani, J., & Pennington, A. (2012). The introduction of keyboarding to students with autism spectrum disorders with handwriting difficulties: A help or a hindrance? *Australasian Journal of Special Education, 36*(1), 32-61. doi:10.1017/jse.2012.6

Barkaoui, K. (2014). Examining the impact of L2 proficiency and keyboarding skills on scores on TOEFL-iBT writing tasks. *Language Testing, 31*(2), 241-259. doi:http://dx.doi.org/10.1177/0265532213509810

Public Broadcasting Service (2017). PBSkids: Games. Retrieved June 8th, 2017 from http://www.pbskids.org

Britten, R. M. (1988). The effects of instruction on keyboarding skills in Grade 2. *Educational Technology*, 28, 34-37.

Brown, C. M. (1988). Comparison of typing and handwriting in "Two-finger typists". Proceedings of the Human Factors Society Annual Meeting, 32(5), 381-385. doi:10.1177/154193128803200533

Cahill, S. M. (2009). Where does handwriting fit in? Intervention in School and Clinic, 44, 223–228. http://dx.doi.org/10.1177/1053451208328826

Christensen, C.A. (2004). Relationship between orthographic-motor integration and computer use for the production of creative and well-structured written text. *British Journal of Educational Psychology*, 74, 551–564, Retrieved from http://search.proquest.com.jproxy.lib.ecu.edu/docview/216965499?accountid=10639

Chwirka, B., Gurney, B., & Burtner, P. A. (2002) Keyboarding and visual-motor skills in elementary students: A pilot study. *Occupational Therapy In Health Care*, 16(2-3), 39-51. doi: 10.1080/J003v16n02_03

Common Core State Standards Initiative (CCSS). (2016). Common core state standards from English language arts & literacy in history/social studies, science, and technical subjects. Retrieved January 31, 2017, from http://www.corestandards.org/wp-content/uploads/ELA_Standards1.pdf

Dunn, B., & Reay, D. (1989). Word processing and the keyboard: Comparative effects of transcription on achievement. *The Journal of educational research*, 82(4), 237-245. Retrieved from http://www.jstor.org/stable/27540347

Fitts, P. M., & Posner, M. I. (1967). *Learning and skilled performance in human performance*. Belmont, CA: Brooks/Cole.

Freeman, A. R., Mackinnon, J. R., & Miller, L. T. (2005) Keyboarding for Students with Handwriting Problems, *Physical & Occupational Therapy in Pediatrics*, 25(1-2), 119-147. DOI: 10.1080/J006v25n01_08

Gillen, G. (2014) Motor function and occupational performance. In B. A. B. Schell, G. Gillen, & M. E. Scaffa (Eds). *Willard & Spackman's occupational therapy* (12th ed., pp. 759-772). Philadelphia, PA: Lippincott Williams & Wilkins

Groeber, M (2017). Speed typing online. Retrieved June 8, 2017 from https://www.speedtypingonline.com/typing-test

Holding, D (2007). Learn typing: Beginner typing lesson. Retrieved June 8, 2017 from http://www.learntyping.org/beginnertypinglesson1.htm

Hoot, J. L. (1986). Keyboarding instruction in the early grades: Must or mistake? *Childhood Education, 63*(2), 95-101. doi:10.1080/00094056.1986.10521749

ISTE Standards for students (2016). The 2016 ISTE standards for students. Retrieved March 6, 2017 from www.iste.org/standards/standards/for-students-2016

James, K.H., & Engelhardt, L. (2012). The effects of handwriting experience on functional brain development in pre-literate students. *Trends in Neuroscience and Education*, 1(1), 32-42. doi: 10.1016/j.tine.2012.08.001

Keyboarding Without Tears: Developmentally Appropriate (2016). *Keyboarding Without Tears*. Retrieved July 24, 2016 from https://www.hwtears.com/kwt/free-demo/overview

Kisner, E. (1984). Keyboarding: A must in tomorrow's world. *The Journal of the international council for computers in education*, 11(6), 21-22.

Mangen, A., & Velay, J. L. (2010). Digitizing literacy: Reflections on the haptics of writing. In M.H. Zadeh (Ed.), *Advances in Haptics* (pp.385-401).

Madison Avenue Elementary (n.d.). School Profile. Retrieved September 17, 2016 from http://www.madison-schools.com/domain/2864.

Madison Avenue Upper Elementary (n.d.). School Profile. Retrieved September 17, 2016 from http://www.madison-schools.com/domain/2418.

Mannsdale Elementary (n.d.). School Profile. Retrieved September 17, 2016 from http://www.madison-schools.com/domain/1451.

Mannsdale Upper Elementary (n.d.). School Profile. Retrieved September 17, 2016 from

    http://www.madison-schools.com/domain/3370/.

Nichols, L. M. (1995) A Comparison of Two Methods for Teaching Keyboarding in the

    Elementary School. *Computers in the Schools*, 11(4), 15-25, doi: 10.1300/
    J025v11n04_03

Niles-Campbell, N., Tam, C., Mays, J., Skidmore, G. (2008) Understanding the development of

    keyboarding skills in students with fine motor difficulties. *Occupational Therapy Now*,
    10(4) 13-15. Retrieved from www.caot.ca

Olsen, J. Z., & Knapton, E. F. (2015) Kindergarten keyboarding teacher's guide. In A. Cassidy,

    Keyboarding Without Tears® workshop sampler keyboarding teacher's guides. Retrieved
    from www.kwtears.com

Perez Alonso, M.A. (2015). Metacognition and sensorimotor components underlying the process

    of handwriting and keyboarding and their impact on learning: An analysis from the
    perspective of embodied psychology. *Procedia social and behavioral science*, 176, 263-
    269. Doi: 10.1016/j.sbspro.2015.01.470

Pisha, B. (1993). *Rates of development of keyboarding skills in elementary school aged students*

    with and without identified learning disabilities (Doctoral Thesis). Harvard University,
    Boston, MA.

Preminger, F., Weiss, P. L., & Weintraub, N. (2004). Predicting occupational performance:

    Handwriting versus keyboarding. *American Journal of Occupational Therapy*, 58(2),
    193–2. doi:10.5014/ajot.58.2.193

Rogers, H., Laehn, J., Lang, A., O'Leary, D., & Sommers, M. (2003). The status of elementary

    keyboarding: A longitudinal study. *Unpublished research study*, Whitewater, WI: UW-
    Whitewater. Retrieved from www.semanticscholar.org

Rogers, J., & Case-Smith, J. (2002). Relationships between handwriting and keyboarding

    performance of sixth-grade students. *American Journal of Occupational Therapy*, 56(1),
    34–39. doi:10.5014/ajot.56.1.34

Schmidt, R. A., & Lee, T. D. (2005). Motor control and learning: A behavioral emphasis (4th

    ed.). Champaign, IL: Human Kinetics.

Stevenson, N. C., & Just, C. (2014). In early education, why teach handwriting before

    keyboarding? *Early Childhood Education Journal*, 42, 4-56. doi:10.1007/s10643-012-
    0565-2

TypingMaster, Inc (2016) Typing Test Pro. Retrieved July 28, 2016 from www.assesstyping.com

United States Census Bureau (2017). American fact finder. Retrieved June 8, 2017 from

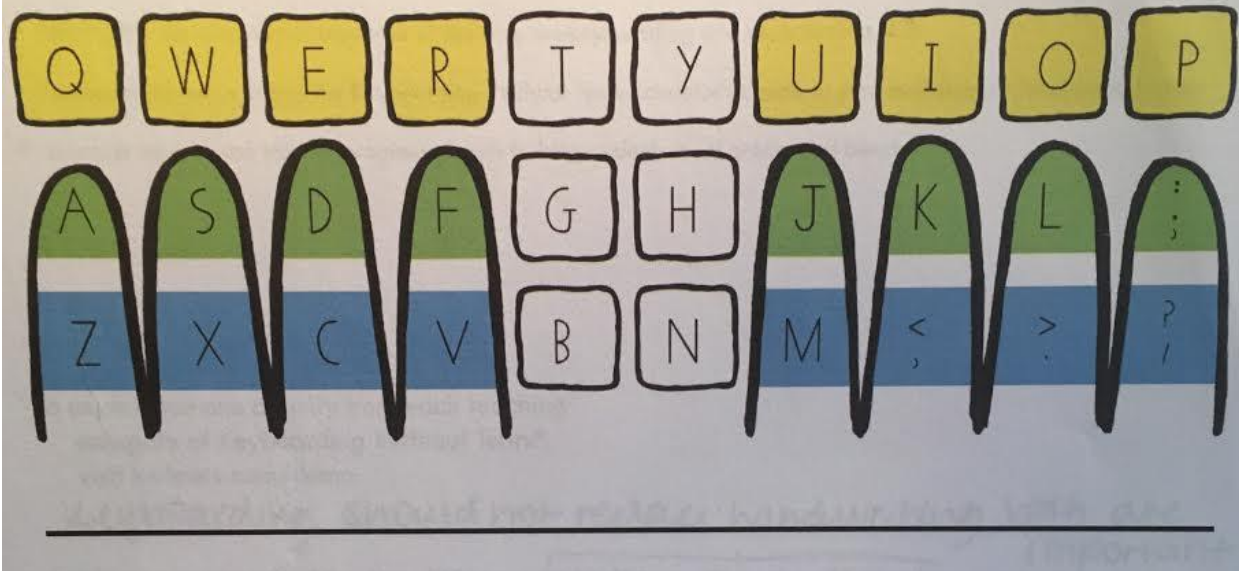   https://factfinder.census.gov/faces/nav/jsf/pages/community_facts.xhtml

Weiglt Marom, H., & Weintraub, N. (2015). The effect of a touch-typing program on

    keyboarding skills of higher education students with and without learning
    disabilities. *Research in Developmental Disabilities, 47*, 208-217.
    doi:http://dx.doi.org/10.1016/j.ridd.2015.09.014

Zwicker, J. G. & Harris, S.R. (2009) A reflection on motor learning theory in pediatric

    occupational therapy practice. *Canadian Journal of Occupational Therapy*, 76(1), 29-37.

Appendixes

APPENDIX A: KEYBOARDING WITHOUT TEARS SAMPLE KEYBOARD

Keyboard for Training Fingers

Kindergarten Teaching Guidelines

TEACHER-LED LESSONS	THEME/WEEK	KEYS	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY
Follow the Rules Color the Rows	Jump In 1		Puzzle Pieces	Letters with Wood Pieces Mat Man® Match	Puzzle Pieces Letters with Wood Pieces	Puzzle Pieces Mat Man® Match	Letters with Wood Pieces Mat Man® Match
Parts of a Computer	Jump In 2		Puzzle Pieces Letters with Wood Pieces	Mat Man® Match Build a Keyboard	Letters with Wood Pieces Puzzle Pieces	Mat Man® Match Letters with Wood Pieces	Puzzle Pieces Build a Keyboard Target Practice
Digital Detectives	Jump In 3		Puzzle Pieces Letters with Wood Pieces	Mat Man® Match Build a Keyboard	Letters with Wood Pieces Puzzle Pieces	Mat Man® Match Letters with Wood Pieces	Puzzle Pieces Build a Keyboard Target Practice
Parts of a Tablet Jumping J with H	Jump In 4		Puzzle Pieces Letters with Wood Pieces	Mat Man® Match Build a Keyboard	Letters with Wood Pieces Puzzle Pieces	Mat Man® Match Letters with Wood Pieces	Puzzle Pieces Build a Keyboard Target Practice
Let's Talk Technology Privacy, Please!	Jump In 5		Puzzle Pieces Letters with Wood Pieces	Mat Man® Match Build a Keyboard	Letters with Wood Pieces Puzzle Pieces	Mat Man® Match Letters with Wood Pieces	Puzzle Pieces Build a Keyboard Target Practice
Perfect Posture	Jump In 6		Puzzle Pieces Letters with Wood Pieces	Mat Man® Match Build a Keyboard	Letters with Wood Pieces Puzzle Pieces	Mat Man® Match Letters with Wood Pieces	Puzzle Pieces Build a Keyboard Target Practice
STOP the Strange ASDF Mnemonic	Let's Eat 7	ASDFG	Build a Keyboard Shuffled Letters	Puzzle Pieces Target Practice Find the Letter	Letters with Wood Pieces Shuffled Letters	Build a Keyboard Target Practice	Shuffled Letters Find the Letter
Keyboard Tour for Teachers JKL; Mnemonic	Off to Work 8	HJKL	Build a Keyboard Shuffled Letters	Puzzle Pieces Target Practice Find the Letter	Letters with Wood Pieces Shuffled Letters	Build a Keyboard Target Practice	Shuffled Letters Find the Letter

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Kindergarten Teaching Guidelines

TEACHER-LED LESSONS	THEME	KEYS	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY
Hike Around Safely	On the Go 9	QWERT	Build a Keyboard Shuffled Letters	Puzzle Pieces Target Practice Find the Letter	Letters with Wood Pieces Shuffled Letters	Build a Keyboard Target Practice	Shuffled Letters Find the Letter
Build a Keyboard Jumping J with U+Y	Let's Eat 10	YUIOP	Build a Keyboard Shuffled Letters	Puzzle Pieces Target Practice Find the Letter	Letters with Wood Pieces Shuffled Letters	Build a Keyboard Target Practice	Shuffled Letters Find the Letter
My Digital Passport	Off to Work 11	ZXCVB	Build a Keyboard Shuffled Letters	Puzzle Pieces Target Practice Find the Letter	Letters with Wood Pieces Shuffled Letters	Build a Keyboard Target Practice	Shuffled Letters Find the Letter
Keyboard Sort	On the Go 12	NM	Build a Keyboard Shuffled Letters	Puzzle Pieces Target Practice Find the Letter	Letters with Wood Pieces Shuffled Letters	Build a Keyboard Target Practice	Shuffled Letters Find the Letter
Digital Citizenship Certification Home, Home on the Row	Let's Eat 13	ASDFG	Painted Finger Clues Zoom In, Zoom Out	Build a Keyboard Shuffled Letters Target Practice	Puzzle Pieces Painted Finger Clues Find the Letter	Build a Keyboard Puzzle Surprise Target Practice	Shuffled Letters Find the Letter Write My Name
Introducing a Keyboard	Off to Work 14	HJKL	Painted Finger Clues Zoom In, Zoom Out	Build a Keyboard Shuffled Letters Target Practice	Puzzle Pieces Painted Finger Clues Find the Letter	Build a Keyboard Puzzle Surprise Target Practice	Shuffled Letters Find the Letter
QWERTY	On the Go 15	QWERT	Painted Finger Clues Zoom In, Zoom Out	Build a Keyboard Shuffled Letters Target Practice	Puzzle Pieces Painted Finger Clues Find the Letter	Build a Keyboard Puzzle Surprise Target Practice	Shuffled Letters Find the Letter
I O U + YOU	Let's Eat 16	YUIOP	Painted Finger Clues Zoom In, Zoom Out	Build a Keyboard Shuffled Letters Target Practice	Puzzle Pieces Painted Finger Clues Find the Letter	Build a Keyboard Puzzle Surprise Target Practice	Shuffled Letters Find the Letter Write My Name

© 2015 Keyboarding Without Tears®   Keys for Me: *Teaching Guidelines*

Kindergarten Teaching Guidelines

TEACHER-LED LESSONS	THEME/WEEK	KEYS	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY
Shift for Capitals	17 Off to Work	ZXCVB	Puzzle Surprise / Target Practice / Build a Keyboard / Zoom In, Zoom Out	Puzzle Pieces / Painted Finger Clues / Find the Letter	Shuffled Letters / Target Practice / Puzzle Surprise	Zoom In, Zoom Out / Painted Finger Clues / Build a Keyboard	Shuffled Letters / Find the Letter
Jumping J with M + N	18 On the Go	NM	Puzzle Surprise / Target Practice / Build a Keyboard / Zoom In, Zoom Out	Puzzle Pieces / Painted Finger Clues / Find the Letter	Shuffled Letters / Target Practice / Puzzle Surprise	Zoom In, Zoom Out / Painted Finger Clues / Build a Keyboard	Shuffled Letters / Find the Letter
Left Hand: ABCDEFG	19 Let's Eat	QWERT ASDFG	Shuffled Letters / Build a Keyboard / Curtain Call	Painted Finger Clues / Find the Letter / Making Space	Shuffled Letters / Puzzle Surprise / Rhyme Flip	Puzzle Pieces / Making Space / Bouncing Vowels	Find the Letter / Dolch Dynamite / Write My Name / **Spot Check: Letters**
Right Hand: HIJKLMNOP	20 Off to Work	YUIOP HJKL	Shuffled Letters / Build a Keyboard / Curtain Call	Painted Finger Clues / Find the Letter / Dump the Combo	Shuffled Letters / Puzzle Surprise / Rhyme Flip	Puzzle Pieces / Find the Letter / Making Space	Find the Letter / Dolch Dynamite / Dump the Combo
Find My Name	21 On the Go	ASDFG ZXCVB	Build a Keyboard / Dump the Combo	Painted Finger Clues / Find the Letter / Letters with Wood Pieces	Dump the Combo / Puzzle Surprise / Shuffled Letters	Making Space / Shuffled Letters / Find the Letter	Find the Letter / Rhyme Flip / Letters with Wood Pieces
Pinkie Punctuation ; ?	22 Let's Eat	HJKL NM	Build a Keyboard / Shuffled Letters / Write My Name	Find the Letter / Painted Finger Clues	Puzzle Surprise / Dump the Combo / Letters with Wood Pieces	Find the Letter / Shuffled Letters	Find the Letter / Letters with Wood Pieces / **Spot Check: Letters**
Keyboard Spelling	23 Off to Work	QWERT ASDFG	Build a Keyboard / Dump the Combo / Curtain Call	Painted Finger Clues / Find the Letter	Puzzle Surprise / Rhyme Flip / Dump the Combo	Making Space / Bouncing Vowels / Find the Letter	Find the Letter / Zoom In, Zoom Out / Dolch Dynamite
Find It, Color It, Write It	24 On the Go	YUIOP HJKL	Build a Keyboard / Dump the Combo / Curtain Call	Painted Finger Clues / Bouncing Vowels / Find the Letter	Puzzle Surprise / Rhyme Flip / Dump the Combo	Making Space / Bouncing Vowels / Find the Letter	Find the Letter / Zoom In, Zoom Out / Dolch Dynamite

© 2015 Keyboarding Without Tears®   Keys for Me: **Teaching Guidelines**

Kindergarten Teaching Guidelines

TEACHER-LED LESSONS	WEEK	KEYS	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY
Q&A	25 Let's Eat	QWERT ASDFG ZXCVB	Build a Keyboard / Painted Finger Clues / Dump the Combo	Find the Letter / Curtain Call / Write My Name	Rhyme Flip / Puzzle Surprise / Dump the Combo	Find the Letter / Making Space	Find the Letter / Making Space / Syllable Pop-Up / **Spot Check: Letters**
E-I, E-I, O	26 Off to Work	YUIOP HJKL NM	Build a Keyboard / Curtain Call	Find the Letter / Painted Finger Clues	Rhyme Flip / Puzzle Surprise / Dump the Combo	Making Space / Find the Letter	Find the Letter / Syllable Pop-Up
Type It!	27 On the Go	QWERT ASDFG ZXCVB	Painted Finger Clues / Bouncing Vowels / Curtain Call	Build a Keyboard / Dump the Combo	Rhyme Flip / Find the Letter / Making Space	Dolch & Space / Syllable Pop-Up	Dolch Dynamite / Pick Me!
Calendar Keyboard	28 Let's Eat	YUIOP HJKL; NM,.	Painted Finger Clues / Bouncing Vowels / Curtain Call	Build a Keyboard / Dump the Combo	Find the Letter / Making Space / Write My Name	Dolch & Space / Syllable Pop-Up	Dolch Dynamite / Rhyme Flip / **Spot Check: Letters**
Shift It, Space It, Punctuate It!	29 Off to Work	QWERT ASDFG ZXCVB	Painted Finger Clues / Bouncing Vowels / Curtain Call	Build a Keyboard / Dump the Combo	Rhyme Flip / Find the Letter / Making Space	Dolch & Space / Rhymes With	Dolch Dynamite / Pick Me! / Syllable Pop-Up
Pencils vs. Keyboards	30 On the Go	YUIOP HJKL; NM,.	Painted Finger Clues / Bouncing Vowels	Build a Keyboard / Dump the Combo	Rhyme Flip / Find the Letter / Making Space	Dolch & Space / Curtain Call	Dolch Dynamite / Pick Me! / Syllable Pop-Up
Find the Finger	31 Let's Eat	All Keys	Painted Finger Clues / Bouncing Vowels / Making Space / Curtain Call	Build a Keyboard / Dump the Combo / The Label Maker (2x)	Rhyme Flip / Making Space / Starts With / The Label Maker (2x)	Rhymes With / Dolch & Space / Pick Me!	Dolch Dynamite / Syllable Pop-Up / Find the Letter / **Spot Check: Words**
	32 Off to Work	All Keys	Painted Finger Clues / Bouncing Vowels / Curtain Call	Build a Keyboard / Dump the Combo / Pick Me!	Rhyme Flip / Starts With / The Label Maker (2x)	Rhymes With / Dolch & Space / Find the Letter	Dolch Dynamite / Syllable Pop-Up / Making Space / **Spot Check: Words**

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Kindergarten Teaching Guidelines

TEACHER-LED LESSONS	THEME/WEEK	KEYS	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY
	33 On the Go	All Keys	Painted Finger Clues / Build a Keyboard / Pick Me!	Bouncing Vowels / Rhyme Flip / Syllable Pop-Up	Dump the Combo / Starts With / The Label Maker (2x)	Rhymes With / Dolch & Space / Making Space	Dolch Dynamite / Curtain Call / Math Masters
	34 Let's Eat	All Keys	Painted Finger Clues / Build a Keyboard / The Label Maker (2x)	Bouncing Vowels / Rhyme Flip / Curtain Call	Dump the Combo / Start With / The Label Maker (2x)	Rhymes With / Dolch & Space / Making Space	Dolch Dynamite / Syllable Pop-Up / Math Masters / **Spot Check: Words**
	35 Off to Work	All Keys	Painted Finger Clues / Syllable Pop-Up	Curtain Call / Starts With / Math Masters	Making Space / The Label Maker (2x)	Rhymes Flip / Dolch & Space	Dolch Dynamite / Rhymes With
	36 On the Go	All Keys	Painted Finger Clues / Syllable Pop-Up	Dolch Dynamite / Curtain Call / Math Masters	Rhymes With / The Label Maker (2x)	Rhymes Flip / Starts With / Dolch & Space	Dolch Dynamite / Making Space / **Spot Check: Words**

APPENDIX C: PRE-TEST DATA FORM

Please print your ID number: _____

Are you a: BOY or GIRL?

Circle what you have at home:

Laptop   Desktop   Tablet (like an iPad®)

Circle what hand you write with.

LEFT   RIGHT

Put a check in ONE box for each question.

Question	Every Day	Once a Week	Once a Month	Never
How often did you use a computer at home during the summer?				
How often did you use a tablet at home during the summer?				

Have you ever been taught keyboarding (typing)?   YES   NO

Pre-Test Data Collection Form
For Researcher Use Only

Pre-Test Observation: 1   2   3   4   5

APPENDIX D: POST-TEST DATA FORM

Please print your ID number: _____

Are you a: BOY or GIRL

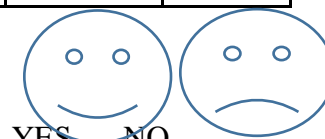Circle what you have at home:

Laptop	Desktop	Tablet

Put a check in ONE box for each question.

Question	Every Day	Once a Week	Once a Month	Never
How often did you use a computer at home during the school year?				
How often did you use a computer at home for school assignments?				
How often did you use a computer in the classroom at school?				

Circle your answer.
1. Did you like the keyboarding games you did in here?   YES   NO
2. Did you look forward to doing the keyboarding games?   YES   NO
3. Do you think you are better at keyboarding now?   YES   NO
4. Would you like to do more keyboarding games?   YES   NO

_____

For Researcher Use Only

Post-Test Observation: 1   2   3   4   5

APPENDIX E: KEYBOARDING SPEED AND ACCURACY TEST

Typing Test Pro

ADMINISTRATOR LOGIN

Welcome to the Typing Test

Please type as quickly and accurately as possible.

This is an online typing skills test organized by East Carolina University - OT. If you have any questions, please contact the test administrator with this contact form.

Please give your your email address below and click Continue.

Enter Your Email Address

Email Address		Required
Confirm Email Address		Required

CONTINUE

Recommended browsers: Chrome, Internet Explorer 10 or later.
Safari and Firefox are supported but may in some rare situations have glitches displaying special characters.

Typing Test Pro

Step 3 of 6 - Practice Test

Warm up your fingers by typing these short test instructions. The test text is shown in the upper part of the screen. Type it as quickly and accurately as possible until the test time is up. The text you have typed is shown in the lower part of the screen. There you can see if you have made any typing errors. Your test administrator has decided if you can use backspace to correct any typing errors. Please do not press enter after each line - only when the paragraph ends.

TypingTest Pro is a website that provides

Click or tap here and start typing!

TIME LEFT
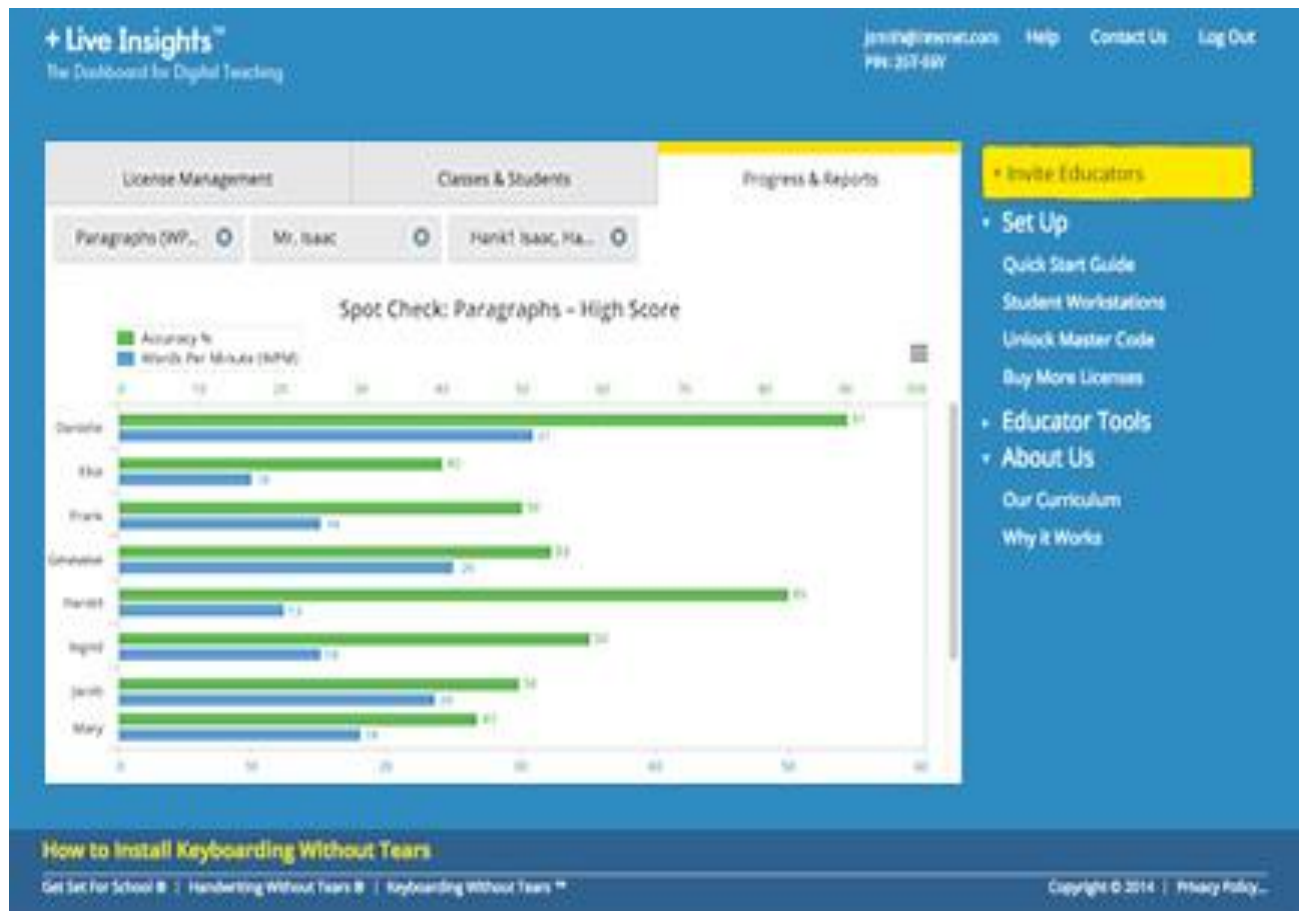
1:00

TYPING SPEED

0
WPM

0
mistyped words

ERRORS

Cancel

Problems? The test doesn't show up at all | Accent letters don't show correctly | Switch to the Flash version of the test

APPENDIX F: KWT USAGE DATA

APPENDIX G: KEYBOARDING PASSAGES

Keyboarding Passages:

Warm-up – 60 seconds (1st grade reading level)

Ann was seven years old. Her brother, Tom was nine. They were both very excited. Today they were going to get a pet. They were going to get a puppy. Ann hoped their new puppy would like to chase balls. She wanted to play with it in the yard. She thought it would be fun to play chase with the puppy. Tom hoped their new puppy would like to go for walks in the park. He wanted to take it for walks with his friends and their dogs. Both children knew that taking care of a puppy could be a lot of work. They promised their mom they would be good pet owners.

1st sample – 60 seconds (1st grade reading level)

Ray was a big fish. He was blue and grey and had large, very round eyes. He had a strong tail. He was a very good swimmer. Ray lived in the Pacific Ocean. He swam all day long. He even swam at night. All this swimming made him very strong. One day, Ray thought he should explore. He swam to a new part of the ocean. He had not been there before. He saw a ship sitting on the sand in the deep water. It was tipped over on its side. There were fish swimming in and out of the ship. With each breath, they sent bubbles floating up to the surface. There was seaweed growing near the ship. It was dark green with big leaves. It waved back and forth in the water. Ray decided to go closer.

2nd sample – 120 second (4th grade reading level)

Last Tuesday when Kathy went to school there was a big surprise. All day, regular school had been cancelled! Instead, they would spend the day learning about different culture. They started their day with an assembly. All of the teachers and students went to the gym. They listened to a woman talk about people living in the United Stated. She showed picture of cities and farms. She showed pictures of people who lived in these places and people from other countries. Each picture was so different from the one before! Kathy thought it was great. She loved learning about people living hundreds of miles away.

When the assembly was over, the students returned to class. Their teacher had a lesson planned on different types of music. She played music from the Andes Mountains. They music had a flute and several drums. It made Kathy shiver because it was so beautiful. Then, her teacher played music from Africa with people chanting and stomping their feet. The music made her smile. She really wanted to dance. They had time for one more type of music. This time, their teacher played music from Scotland. At first, it sounded as through an animal was howling. Then, the classroom filled with a sound unlike anything Kathy had ever heard. It was the first time Kathy had ever heard bagpipes! They rumbled and bellowed and even squeaked. Kathy was inspired. She knew that someday she wanted to travel and listen to all of this music in person.

Excerpts taken from Alonzo & Tindal (2006) at the University of Oregon

APPPENDIX H: UMCIRB APPROVAL

EAST CAROLINA UNIVERSITY
University & Medical Center Institutional Review Board Office
4N-70 Brody Medical Sciences Building· Mail Stop 682
600 Moye Boulevard · Greenville, NC 27834
Office **252-744-2914** · Fax **252-744-2284** · **www.ecu.edu/irb**

Notification of Initial Approval (Committee)

From: Social/Behavioral IRB
To: Denise Donica
CC:

Date: 6/3/2016
Re: UMCIRB 16-000531
        Keyboarding Without Tears to Improve Keyboarding Skills of Children

I am pleased to inform you that at the convened meeting on 5/18/2016 of the Social/Behavioral IRB, the committee voted to approve the above study. Approval of the study and the consent form(s) is for the period of 5/18/2016 to 5/17/2017.

The Social/Behavioral IRB deemed this study Minimal Risk.

Changes to this approved research may not be initiated without UMCIRB review except when necessary to eliminate an apparent immediate hazard to the participant. All unanticipated problems involving risks to participants and others must be promptly reported to the UMCIRB. The investigator must submit a continuing review/closure application to the UMCIRB prior to the date of study expiration. The investigator must adhere to all reporting requirements for this study.

Approved consent documents with the IRB approval date stamped on the document should be used to consent participants (consent documents with the IRB approval date stamp are found under the Documents tab in the study workspace).

The approval includes the following items:

Document	Description
Ashlynn Faircloth CITI Training(0.01)	Additional Items
COI Page 1 Donica(0.01)	COI Disclosure Form
COI Page 2 Donica(0.01)	COI Disclosure Form
COI Page 3 Donica(0.01)	COI Disclosure Form
KWT Proposal(0.02)	Study Protocol or Grant Application
Letter of support(0.01)	Dataset Use Approval/Permission
Parent Flyer Back Page(0.01)	Recruitment Documents/Scripts
Parent Flyer Front Page(0.01)	Recruitment Documents/Scripts
Peter Giroux CITI Training(0.01)	Additional Items
Post-Test(0.01)	Standardized/Non-Standardized Instruments/Measures
Pre-Test(0.01)	Standardized/Non-Standardized Instruments/Measures
Summer Permission Form(0.01)	Consent Forms
Teacher/Staff Survey(0.01)	Surveys and Questionnaires
Teacher/Staff Survey(0.01)	Standardized/Non-Standardized Instruments/Measures

The following UMCIRB members were recused for reasons of potential for Conflict of Interest on this research study:

None

The following UMCIRB members with a potential Conflict of Interest did not attend this IRB meeting:

None

APPENDIX I: LETTER OF SUPPORT

MADISON COUNTY SCHOOLS

MARK OF EXCELLENCE

SUPERINTENDENT
Dr. Ronnie McGehee

BOARD OF EDUCATION
Sam Kelly, President
Philip Huskey, Secretary
Dr. Pollia Griffin
William Grissett
Ken McCoy

July 22, 2016

To Whom it May Concern,

Madison County Schools (MCS) located in Madison, Mississippi is pleased to partner with Dr. Peter Giroux and Dr. Denise Donica and the Occupational Therapy Department at East Carolina University to deliver the Keyboarding Without Tears program as part of a research study to Madison Avenue Elementary School and Madison Avenue Upper Elementary School during the 2016-2017 and 2017-2018 academic school years. In addition, MCS is aware and supportive of the utilization of Mannsdale Elementary School and Mannsdale Upper Elementary School as a control population for the 2016-2017 academic school year with the understanding that these schools will be invited to participate in the Keyboarding Without Tears program for the 2017-1018 school year and continued involvement in the study. MCS will comply with all reasonable requests for documentation of program delivery including aggregated statistics about students served, attendance records and pre and post assessment. MCS is aware of and is supportive of an "opt out" clause for those individuals that may not want to participate in the research study but remain fully supportive of obtaining outcome information on the Keyboarding Without Tears program as it will be the school wide curriculum for all students at Madison Avenue Elementary and Madison Avenue Upper Elementary for the 2016-2017 school year. MCS will require staff involved in the program to participate in any necessary training or meetings to ensure the program is mutually beneficial to all parties involved.

MCS is grateful for the opportunity to provide this program to our students as we believe that it aligns closely with our motto, "Madison County Schools: Mark of Excellence". In addition, we believe that the keyboarding program addresses the goals and objectives of the new keyboarding standards for the state of Mississippi.

Sincerely,

Dr. Brenda Jones
Principal, Madison Avenue Elementary Principal,

Dr. Emily Mulhollen
Principal, Mannsdale Elementary

Dr. Ronnie McGehee
Superintendent, Madison County Schools

Mrs. Kim Hurst
Madison Avenue Upper Elementary

Mrs. Debra Houghton
Principal, Mannsdale Upper Elementary

476 Highland Colony Parkway, Ridgeland, MS 39157   Phone: 601.879.3000 Fax: 601-879-3039

East Carolina University.

**College of
Allied Health Sciences**
Health Sciences Building
East Carolina University
Greenville, NC 27834

www.ecu.edu/ah

Dean's Office
252-744-6010
www.ecu.edu/ah/administration.cfm

Addictions and Rehabilitation
Studies
252-744-6300
www.ecu.edu/rehb

Biostatistics
252-744-6045
www.ecu.edu/bios

Clinical Laboratory Science
252-744-6064
www.ecu.edu/clsc

Communication Sciences
and Disorders
252-744-6102
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Health Services and
Information Management
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www.ecu.edu/hsim

Nutrition Science
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www.ecu.edu/nutr

Occupational Therapy
252-744-6199
www.ecu.edu/ot

Physical Therapy
252-744-6238
www.ecu.edu/pt

Physician Assistant Studies
252-744-6271
www.ecu.edu/pa

Dear Parent/Guardian,

As part of educational research being conducted through the Occupational Therapy Department at East Carolina University in conjunction with Handwriting Without Tears® and Madison County Schools, your child is being invited to participate in an exciting learning opportunity. This opportunity is a research project to take place as part of curriculum at your child's school and will help us learn more about the development of keyboarding skills in children. The fundamental goal of this research study is to determine how much children's keyboarding skills improve when they complete activities within the developmentally-based Keyboarding Without Tears® program.

For the 2016-2017 school year and the 2017-2018 school year (for students at Madison Avenue Elementary or Madison Avenue Upper Elementary School) your child will be given a FREE annual license for the Keyboarding Without Tears program and will participate in various keyboarding activities during his/her regular education this school year and next school year. As part of the research study, the data on your child's performance in keyboarding will be collected that will allow us to track keyboarding skill development. We will also be collecting your child's attendance records and aggregated statistics which may include demographic information, reading level, and identification of receiving special education services. This information will be used ONLY in analysis of the keyboarding program effectiveness and it will NOT be associated with your child's name in any way. As this study is for educational research purposes only, the results of your permission to allow us to collect your child's data **will not** affect your child's grade. If you do not want your child's data included, please sign the "opt out" list in the office at your child's school. Please know that participation is entirely voluntary. Please note that Drs. Donica and Giroux are part-time employees of Learning Without Tears who developed the program being used in this study.

If you have any questions or concerns, please feel free to contact Dr. Denise Donica at ECU at 252-744-6197 or by emailing donicad@ecu.edu. You may also contact Dr. Peter Giroux by phone at 601-856-6609 or by email at pgiroux@madison-schools.com. If you have questions about your child's rights as someone taking part in research, you may call the Office of Research Integrity & Compliance (ORIC) at phone number 252-744-2914 (days, 8:00 am-5:00 pm). If you would like to report a complaint or concern about this research study, you may call the Director of the OHRI, at 252-744-1971.

Your Partners in Education,

Denise Donica, DHSc, OTR/L, BCP, FAOTA
Associate Professor
East Carolina University

Peter Giroux, PhD, OTR/L, FAOTA
Occupational Therapist
Madison County Schools

*East Carolina University is a
constituent institution of the
University of North Carolina.*

An equal opportunity university.

APPENDIX K: PARENTAL CONSENT FORMS CONTROL SCHOOLS

East Carolina University.

College of
Allied Health Sciences
Health Sciences Building
East Carolina University
Greenville, NC 27834

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Dear Parent/Guardian,

As part of educational research being conducted through the Occupational Therapy Department at East Carolina University in conjunction with Handwriting Without Tears® and the Madison County Schools, your child is being invited to participate in an exciting learning opportunity. This opportunity is a research project to take place as part of the curriculum at your child's school and will help us learn more about the development of keyboarding skills in children. The fundamental goal of this research study is to determine how much children's keyboarding skills improve when they complete activities within the developmentally-based Keyboarding Without Tears® program.

For the 2016-2017 school year your child will participate in some basic keyboarding activities to measure keyboarding skills at the beginning and end of the 2016-2017 school year. During the 2017-2018 school year (for students in k-5th grade at Mannsdale Elementary and Mannsdale Upper Elementary), your child will be given a FREE annual license for the Keyboarding Without Tears program and will participate in various keyboarding activities during his/her regular education in addition to the basic keyboarding activities used to measure outcomes at the beginning and end of the year. As part of the research study, the data on your child's performance in keyboarding will be collected that will allow us to track keyboarding skill development. We will also be collecting your child's attendance records and aggregated statistics which may include demographic information, reading level, and identification of receiving special education services. This information will be used ONLY in analysis of the keyboarding program effectiveness and it will NOT be associated with your child's name in any way. As this study is for educational research purposes only, the results of your permission to allow us to collect your child's data **will not** affect your child's grade. If you do not want your child's data included, please sign the "opt out" list in the office at your child's school. Please know that participation is entirely voluntary. Please note that Drs. Donica and Giroux are part-time employees of Learning Without Tears who developed the program being used in this study.

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Your Partners in Education,

Denise Donica, DHSc, OTR/L, BCP, FAOTA
Associate Professor
East Carolina University

Peter Giroux, PhD, OTR/L, FAOTA
Occupational Therapist
Madison County Schools

KEYBOARDING Without Tears®

LEARN MORE!
kwtears.com/learnmore

NEW, game-based curriculum is being used for research purposes for K-5th grade students which fits perfectly into the developmental progression of writing. It teaches pre-keyboarding and keyboarding alongside general computer readiness.

- Flexible classroom set-ups for computer or tablets
- Builds skills needed for PARCC, Smarter Balanced, and other computer-based testing
- Develops foundation technology skills to meet ISTE® and Common Core standards

Easy to Teach

- Grade-level appropriate curriculum
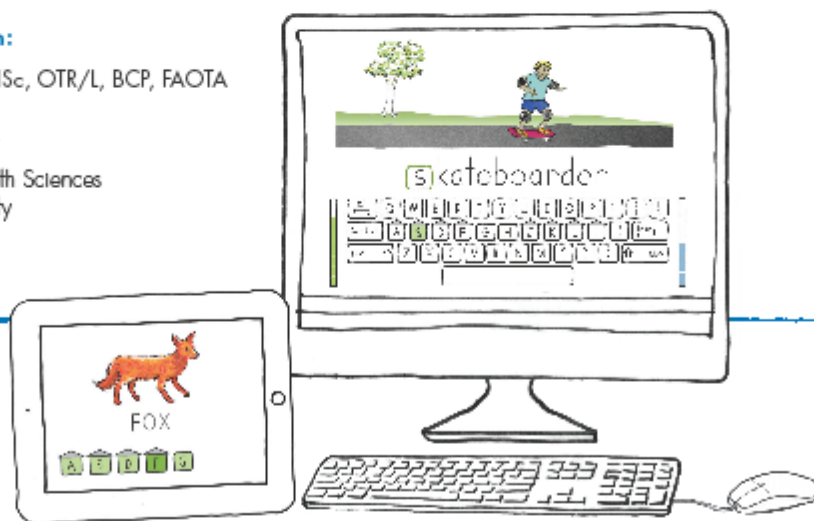- Developmental teaching order

Easy to Learn

- Color-coded rows
- Dynamic keyboard and cursor
- Unilateral hand and finger skills

Rich Content

- Digital citizenship
- Theme-based, cross-curricular content

Contact information:

Denise K. Donica, DHSc, OTR/L, BCP, FAOTA

Associate Professor
Occupational Therapy

College of Allied Health Sciences
East Carolina University
Greenville, NC

donicad@ecu.edu

skateboarder

FOX

GET SET FOR SCHOOL® Pre-K | Handwriting Without Tears® K-5 | KEYBOARDING Without Tears® K-5

KEYBOARDING Without Tears® Curricula Used at Each Grade Level

Keys for Me
Kindergarten

Get ready for keyboarding with activities that develop fine motor skills, introduce the keyboard and mouse functions, teach left and right hands separately, and reinforce handwriting skills with typing games.

My Keying Board
First Grade

Dive into first grade lessons with game-based lessons for finger dexterity, drag and drop skills, finger-key association, and typing letters and words. Students collect awards as they progress through the program.

Key Power
Second Grade

Develop key power with engaging keyboard activities that build muscle memory. Students learn the entire keyboard and build skills through practicing common letter combinations, frequently used short words, and sentences.

Keyboarding
Third Grade

Students review and master foundational early keyboarding skills, and quickly move into learning number and function keys, formatting, and typing paragraphs. Lessons reinforce fine motor memory, increase accuracy, and prepare students to navigate computer-based assessments.

Keyboarding Success
Fourth Grade

Students succeed in keyboarding with speed and fluency. Typing activities strengthen muscle memory in frequently used letter combinations and reinforce skills for navigating computer-based assessments. Lessons enhance language arts and creative writing instruction.

Can-Do Keyboarding
Fifth Grade

Your students will develop the accuracy and speed necessary to handle the demands of schoolwork and testing in higher grades. Students learn about interesting subjects with paragraph practice and other engaging opportunities.

This study is for research purposes. K–5th grade students at this school, in collaboration with East Carolina University Occupational Therapy Department and Learning Without Tears, are offered the opportunity to participate in this experience to learn keyboarding skills where non-identified information will be collected for research purposes. There is no cost. Please sign the list to "opt out" of the study in the school office if you do not want your child involved in the research data collection.

If you have any questions or concerns, please contact Dr. Donica at East Carolina University. If you have questions about your child's rights as someone taking part in research, you may call the Office of Research Integrity & Compliance (ORIC) at phone number 252-744-2914 (weekdays, 8:00 am-5:00 pm). If you would like to report a complaint or concern about this research study, you may call the Director of the OHRI, at 252-744-1971.
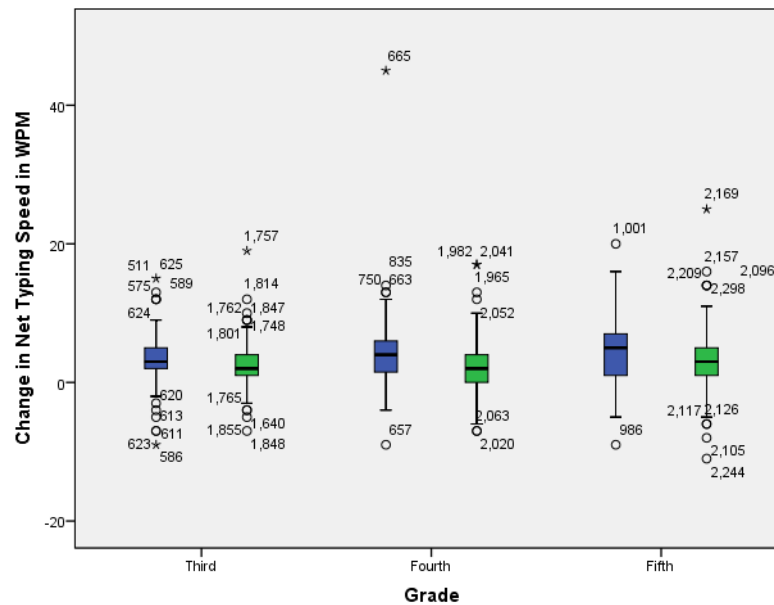
GET SET FOR SCHOOL® Pre-K | **Handwriting Without Tears**® K–5 | KEYBOARDING **Without Tears**® K–5

APPENDIX M: CHANGE IN NET TYPING SPEED BOX PLOTS FOR 2-MINUTE KEYBOARDING SPEED AND ACCURACY TEST
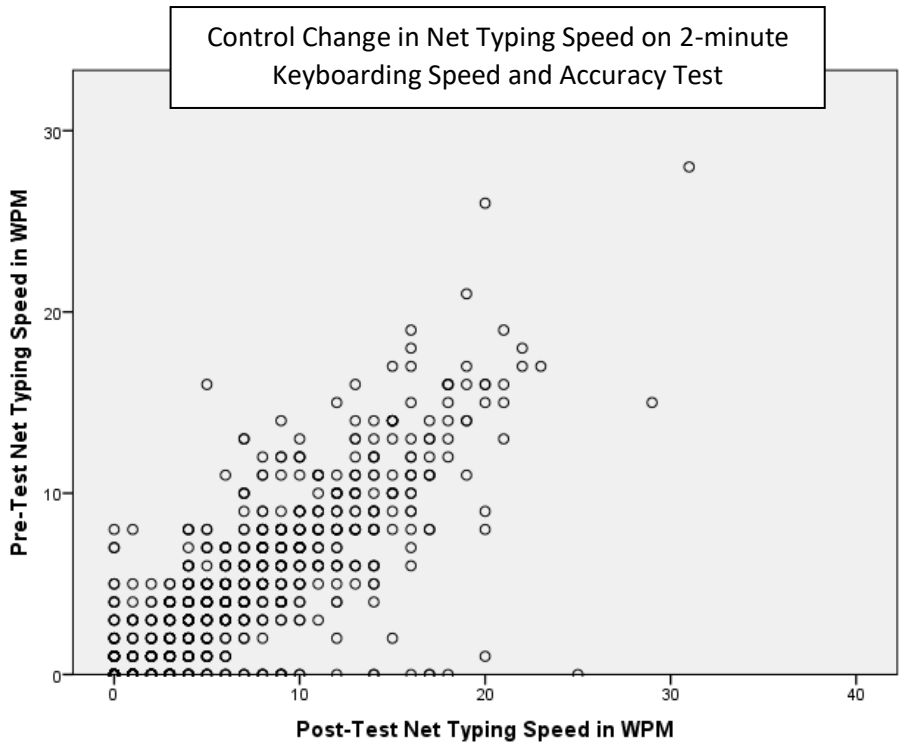

Change in Net Typing Speed on 2-minute Keyboarding Speed and Accuracy Test
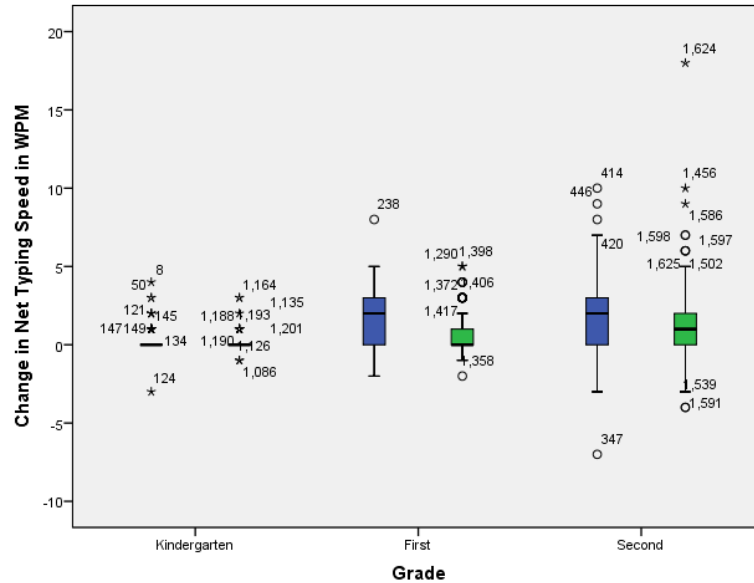
Change in Net Typing Speed on 2-minute Keyboarding Speed and Accuracy Test

APPENDIX N: CHANGE IN NET TYPING SPEED SCATTER PLOTS FOR 2-MINUTE KEYBOARDING SPEED AND ACCURACY TEST
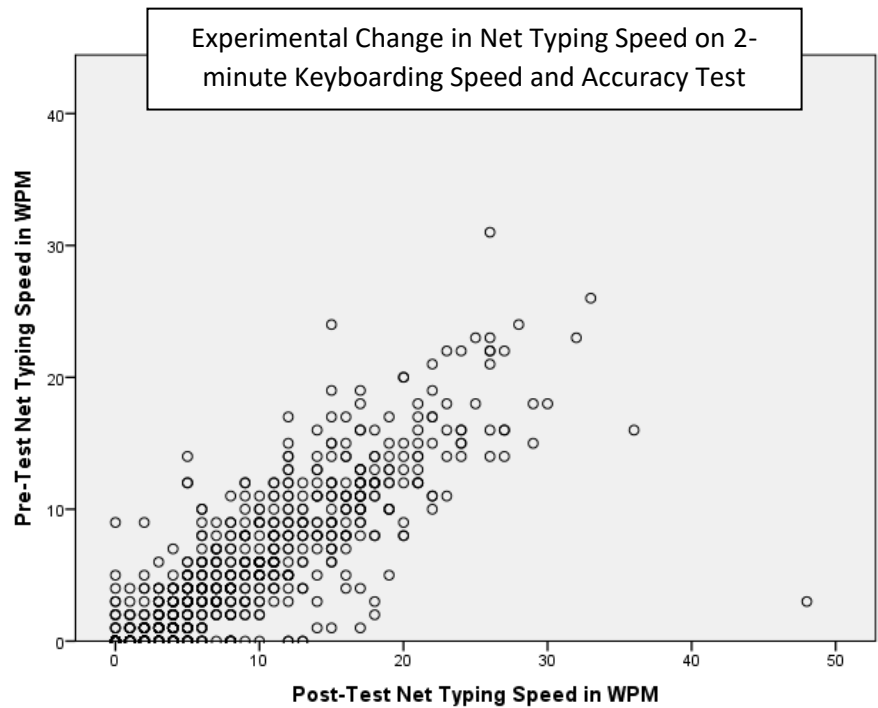

Experimental Change in Net Typing Speed on 2-minute Keyboarding Speed and Accuracy Test

Control Change in Net Typing Speed on 2-minute Keyboarding Speed and Accuracy Test

APPENDIX O: SCATTER PLOTS FOR LINEAR REGRRESSION FOR 2-MINUTE
KEYBOARDING SPEED AND ACCURACY TEST

Relationship Between KWT Activities Completed and Change in Net Typing Speed on 2-minute Keyboarding Speed and Accuracy Test
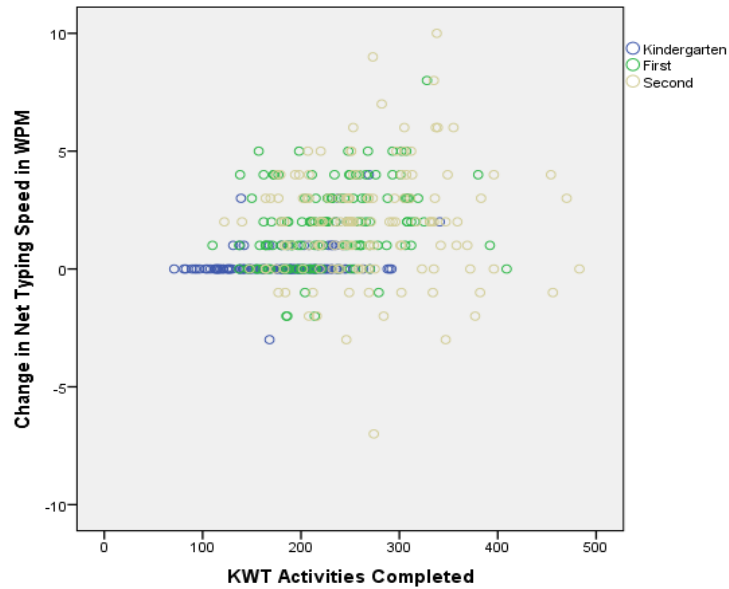
Relationship Between KWT Activities Completed and Change in Net Typing Speed on 2-minute Keyboarding Speed and Accuracy Test

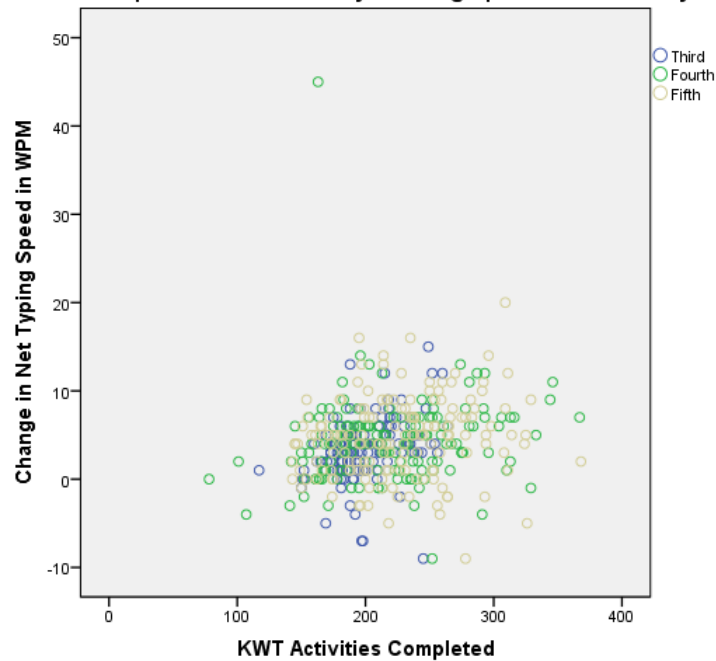# APPENDIX P: RESULTS OF T-TEST FROM 2-MINUTE KEYBOARDING SPEED AND ACCURACY TEST

Results of t-tests and Descriptive Statistics Change in Net Typing Scores on 2-minute Keyboarding Speed and Accuracy test by KWT Treatment

Outcomes	Group						95% CI for Mean Difference	t	df
	Experimental			Control					
	M	SD	n	M	SD	n			
Kindergarten	0.19	0.67	144	0.08	0.43	165	-0.02,0.23	1.62	307
First	1.70	1.70	143	0.83	1.23	161	0.54,1.20	5.15*	302
Second	1.94	2.36	139	1.28	2.52	182	0.12, 1.21	2.40	319
Third	3.36	3.38	144	2.21	3.17	163	0.41,1.88	3.07*	305
Fourth	4.29	4.93	156	2.37	3.61	183	1.01,2.84	4.15*	337
Fifth	4.61	4.52	163	2.88	4.25	165	0.78,2.68	3.57*	326

* $p < 0.01$

ANOVA Results and Descriptive Statistics for Mean Differences in Net Typing Speed on 2-minute Keyboarding Speed and Accuracy test by KWT Treatment

Variable	M	SD	n
Experimental			463
Third	3.36	3.38	144
Fourth	4.29	4.93	156
Fifth	4.61	4.52	163
Control			511
Third	2.21	3.17	163
Fourth	2.37	3.61	183
Fifth	2.88	4.25	165

Source	SS	df	MS	F
Experimental vs Control	632.62	1	623.62	39.10*
Grade	140.35	2	70.17	4.34
Error	15694.20	970	16.18	

*$p<0.001$

Comparisons of Mean differences in Experimental and Control Schools by Grade for Net Typing Speed on 2-Minute Keyboarding Speed and Accuracy test

Comparison	Estimated Mean difference	Standard Error of Difference	t	95% Confidence Intervals
Experimental vs Control	1.62*	0.26	6.25	1.11, 2.12

*$p<0.05$.

APPENDIX R: RESULTS OF LINEAR REGRESSION FROM 2-MINUTE KEYBOARDING
SPEED AND ACCURACY TEST

*Results of Linear Regression Predicting Change in Net Typing Speed Based on Amount of KWT
Activities Completed*

Variables	N	R^2	B	95% CI	P
2-Minute Timed Typing Test	889	.03	0.01	0.01,0.02	0.00
Kindergarten	144	.06	0.00	0.00,0.01	0.00
First	143	.11	0.01	0.01, 0.02	0.00
Second	139	.01	0.00	-0.00, 0.01	0.36
Third	144	.14	0.05	0.03, 0.07	0.00
Fourth	156	.01	0.13	-0.00, 0.03	0.09
Fifth	162	.02	0.15	0.00, 0.03	0.05

APPENDIX S: PRE-TEST AND POST-TEST NET TYPING SPEED

Pre-Test Net Typing Speed Scores on 1 minute Timed Typing Test

Pre-Test Net Typing Speed Scores on 2 minute Timed Typing Test

Post-Test Net Typing Speed Scores on 1 minute Timed Typing Test

Post-Test Net Typing Speed Scores on 2 minute Timed Typing Test