A COMPARISON OF THE EFFICACY OF THE KEYBOARDING WITHOUT TEARS ® PROGRAM AND MIXED METHOD INSTRUCTION

by

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Abstract

The purpose of this study was to investigate the two-year impact of using the Keyboarding Without Tears® instruction program compared to a mixed method instruction approach on students' net typing words per minute (WPM) and technique. In the current technological era, it is becoming increasingly important for students to possess keyboarding skills so that they are successful in education, social activities, and future work. Although the Common Core State Standards (National Governors Association & Council of Chief School Officers, 2010) emphasize the use of technology, including keyboarding, across grades, there has been no systematic implementation of keyboarding in schools (Poole & Preciado, 2016). This is largely due to the fact that there is not enough research identifying how the effectiveness of keyboarding interventions would balance the cost of implementing these interventions. This study utilized a pre-test post-test design over a two-year intervention period to measure the effectiveness of the two different instruction programs. Results revealed that students in the Keyboarding Without Tears group had significant improvements in their keyboarding speed in second and third grade and their keyboarding technique in all grades as compared to students in the mixed methods group. Results also indicated that both forms of keyboarding curriculum are effective at significantly improving students' keyboarding speed and technique. Occupational therapists and

teachers can utilize this information to support the implementation of a keyboarding curriculum in schools and improve the keyboarding skills of students that need improvement with this skill.

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CHAPTER 1: INTRODUCTION

This research study examined the 2-year impacts of implementing a developmentally-based keyboarding instruction application compared to a mixed method keyboarding instruction approach within the elementary school setting for grades kindergarten through fifth. To examine this impact, two different keyboarding instruction approaches were used at four public elementary schools in Mississippi (two kindergarten through second grade schools and two third through fifth grade schools). One pair of schools, Madison Avenue Elementary (K-2) and Madison Avenue Upper Elementary (3-5), used the KWT program for two years (2016-2017 and 2017-2018), whereas Mannsdale Elementary (K-2) and Mannsdale Upper Elementary (3-5) used the Keyboarding Without Tears (KWT) program for only the second year of the study (2017-2018) while receiving instruction through free web-based activities the first year (2016-2017).

To evaluate the impact of each approach, researchers measured and compared the change in the students' in net typing words per minute (WPM) and change in keyboarding technique from the beginning of the first year to the end of the second year of the study between grades at each school. This study provided insight into whether using KWT for more than one year would provide an additional benefit in student keyboarding skill development as compared to using a mixed method keyboarding instruction approach. This is an important area of research for occupational therapy because, in this technological era, keyboarding is a skill that children and adults must possess to be successful in their occupations in school, in the professional world, and possibly in their personal lives. Thus, understanding the effectiveness of the KWT program and identifying the types of keyboarding programs that predispose children to better performance outcomes in keyboarding is useful information for future keyboarding interventions in the school and clinical settings.

Although keyboarding has been recognized as an important skill for students to learn, there has been no systematic implementation of keyboarding in schools (Poole & Preciado, 2016). This is largely due to the fact that there is not enough research showing how the effectiveness of keyboarding interventions would balance the cost of implementing these interventions. This research provides information that will improve the knowledge base about keyboarding programs and spark future research that looks into further uncovering keyboarding and its benefits.

CHAPTER 2: LITERATURE REVIEW

Technological Society

In a variety of occupations, most writing is done with digital writing devices rather than writing by hand (Mangen & Velay, 2010). As America becomes more reliant on technology, more jobs are requiring people to use technology and possess keyboarding skills. Over 50% of today's jobs require computer skills, and that percentage is expected to increase to 77% in 2023 (Donne, 2012; Microsoft IT Academy, 2013). Computer skills are essential for 80% of "middle-skill" jobs, which includes office assistants, sales representatives, retail supervisors and recruiters, and makes up 39% of the job market (Soergel, 2015). These skills are also necessary for higher-level and entry-level positions and having higher net WPM improves the resume of job candidates (Typesy, 2014). In almost all positions, keyboarding skills are necessary for employees to write reports effectively and efficiently, create presentations, and complete everyday work-related tasks. Furthermore, word processing programs, which require keyboarding skills, are one of the most used applications in professional settings (Day, Janus & Davis, 2005). Therefore, establishing and maintaining keyboarding skills will be critical for future job marketability.

Computers are now used for more than just work. Because of the rise in digital technology use, keyboarding has become increasingly used in interpersonal communication; Day et. al noted that most adult Internet users use the Internet to send and receive email and to get information on products and services (2005). The use of e-mail or instant messaging has increased from 12% of adult Internet users in 1997 to 55% in 2003 (Day et. al, 2005). Consistent with this upward trend, a 2011 Internet survey found that 92% of online adults email and use search engines to find information (Purcell, 2011). Additionally, many professional

organizations require employees to communicate through email or instant messaging, so it is important that employees have the keyboarding skills necessary to effectively engage in work participation. Furthermore, with the rise of social media, Americans are using their computer and keyboarding skills to navigate these platforms, exemplified by the 68% of U.S. adults that use Facebook and 81% of millennials check Twitter daily (Lister, 2018).

Keyboarding skills are also becoming necessary and used by Americans fulfilling the consumer role. Online services that require keyboarding proficiency, such as banking and online shopping are also becoming increasingly popular, as 81% of adults now do their finances online (Jenkins, 2016) and 72% of US consumers search for products online before buying them online or in stores (Statista, 2017). Overall, keyboarding proficiency is necessary in work, social, and consumer settings and is "crucial to the development of 21st century skills" (Poole & Preciado, 2016, p. 8).

Handwriting and Keyboarding Skills

Handwriting is one of the most important tools that children use throughout their years of schooling, as it promotes participation in education and school activities (Preminger, Weiss, & Weintraub, 2004). Difficulty with handwriting legibility, speed, and ability is not uncommon and often causes students to fall behind academically or have a decreased ability express themselves in the educational environment (Rogers & Case-Smith, 2002). Additionally, problems with spelling, grammar, and revision are problems encountered by many students (Graham, 2006). To ensure that children do not fall behind with their education participation, they may use the viable compensatory alternative of keyboarding (Preminger et. al, 2004). Keyboarding improves legibility, efficiency of the writing process, the ability to correct errors, productivity, and quality of a child's work (Morphy & Graham, 2012; Preminger et. al, 2004). Keyboarding also frees up

cognitive resources necessary for writing, and this benefit can greatly improve writing efficiency (Poole & Preciado, 2016). Additionally, children who lack motivation for typical handwriting tasks have also been shown to engage more readily in writing when provided with a word processor (Morphy & Graham, 2012). In addition to the proven benefits of using keyboarding as an alternative, word processing software also often provides supplementary supports to students struggling with writing such as spelling and grammar checks, software for formatting text, text to speech capabilities, speech to text capabilities, and planning and outlining software (Morphy & Graham, 2012).

The differences among the underlying performance skills of keyboarding and handwriting indicate that children with relatively poor handwriting can still be effective in keyboarding by the developing unique skills related to keyboarding (Rogers & Case Smith, 2002). The underlying skills correlated with accurate handwriting include left-right discrimination, tactile perception, kinesthetic ability, visual motor integration, and spatial perception (Preminger et. al, 2004). The underlying performance components correlated with keyboarding accuracy include tactile perception, kinesthetic ability, bilateral coordination, and motor and visual memory (Preminger et. al, 2004). Like handwriting accuracy, keyboarding accuracy is correlated with tactile perception and kinesthetic ability; however, only keyboarding accuracy is correlated with bilateral coordination, motor memory, and visual memory functions (Preminger et. al, 2004). Thus, while handwriting requires more linguistic, sensory, and perceptual-cognitive skills, keyboarding demands more motor coordination functions. The different skill sets required for each activity indicate that even if children have weaknesses in sensory and cognitive performance skills that correlate with handwriting, they may still be successful at keyboarding if they have strengths in motor areas correlated with keyboarding.

Although it requires different skills than handwriting, developing keyboarding skills is important, as keyboarding can be used as practical tool for ensuring children's participation in every day social and educational activities.

A meta-analysis examining the impacts of the use of word processors has shown that, in general, word processing has a positive impact on writing for students (Morphy & Graham, 2012). A word processor is defined as a device that enables people to write text and modify it by entering commands and characters from a keyboard, and thus it is directly related to keyboarding (Beal, n.d.). A variety of studies have shown that students using word processors produced larger writing gains than writing by hand, and that it specifically had a positive effect on writing output and quality for students in elementary school to college (Bangert-Drowns, 1993; Graham & Perrin, 2007; Goldberg, Russell, & Cook, 2003). Furthermore, for students experiencing difficulty with writing, word processing has been shown to enhance these students' motivation to write, and improve their writing quality, development and organization, length, and mechanical correctness (Morphy & Graham, 2012).

Keyboarding Instruction

When to teach keyboarding. Research varies regarding the appropriate age to begin keyboarding instruction, and most research regarding keyboarding instruction was done from late 1980 to early 1990 because this was the time that computers first started being used in classrooms. More current practices are not well represented in research. The following information used the most current research available to reflect what has been found about keyboarding instruction.

Some research suggests that formal keyboarding instruction should begin as early as kindergarten, as this is the age at which students are first asked to input information into the computer (McEntee, 1994). Hoot (1996) suggests that kindergarteners have the capability to develop speed and accuracy through keyboarding programs, but Goins (1996) questions whether young elementary school students have the capability to type efficiently or retain what they have learned. Although kindergarteners have not yet mastered the alphabet, keyboarding instruction at this age may be useful as it can help these students learn to better identify letters. Keyboarding instruction for students in kindergarten to second grade should primarily aim to help students locate keys on the keyboard (Jackson, 1986). Chang (1995) indicates that physical and intellectual ability necessary for keyboarding does not develop until 10-12 years old, and therefore this is the time when keyboarding instruction should begin. Similarly, Freeman et al. (2005) suggest that 10-12 years old is the appropriate time to begin keyboarding instruction because it takes less time to develop competency at this age. But, many other studies indicate that third grade is generally the most effective time to begin keyboarding as this is the time when students have a demonstrated interest in learning keyboarding and have reached the physiological development necessary to be proficient keyboarders (Behymer & Echternacht, 1987; Jackson & Berg, 1986; Kercher & McClurg, 1985; King & Alloway 1993; Tenney & Osguthorpe, 1990). Furthermore, a meta-analysis examining the effects of various writing instruction indicated that keyboarding instruction provided to students in first through sixth grade produced positive effects for students both struggling and performing well with writing (Graham, McKeown, Kiuhara & Harris, 2012). In summary, there have been conflicting recommendations on the appropriate age for keyboarding instruction, and for use in evidence-based practice, more

current research regarding the most effective age to begin keyboarding instruction is urgently needed.

How much to teach keyboarding. The educational system in the United States recognizes the educational, social, and occupational importance of learning keyboarding, and this is reflected in the high percentage (75%) of school districts currently providing some keyboarding instruction at the elementary level (Cellante, Graham, Kavanaugh & Shank, 2010). Additionally, the Common Core State Standards (National Governors Association & Council of Chief School Officers, 2010) have emphasized using technology to support writing and provided benchmarks for a variety of writing skills and applications (including typing, sentence construction, reading comprehension, and narrative writing) that students are expected to master at each grade and across grades. The National Business Education Association suggests that keyboarding instruction begin in third or fourth grade and consist of "25-45 total hours of instruction in touch typing, using 20-45-minute lessons for a minimum of three days a week" (Donne, 2012, p. 202). While some instructors believe that students will learn typing skills on their own, an instructional typing course beginning at third grade would allow students the opportunity to develop typing automaticity (Poole & Preciado, 2016). As students move up in grade level, an increase in instructional time and complexity is suggested, so that students can improve their form, speed, and accuracy (Donne, 2012). Research also suggests that a child's initial keyboarding instruction should be followed with further instruction to reinforce the skill effectively (Boyce, 1992; Kahn & Freyd, 1990; McEntee, 1994). Although there is no conclusive research regarding the intensity of reinforcement needed, a child's keyboarding skills are unlikely to improve if there is not consistent reinforcement, regardless of the grade level in which keyboarding is initially taught. McEntee (1994) states that teachers "at the grade level

where keyboarding is introduced—and at all levels above, no matter what subject they teach—should be trained to provide reinforcement activities" for keyboarding (p. 14).

Types of teaching methods. There are a variety of methods that have been used to teach keyboarding, including computer tutorials, video tutorials, and textbook education. Although past research from McClurg and Kercher (1989) found that students using a textbook to learn keyboarding significantly outperformed students using computer or video tutorials, more current research from Russin (1995) found that there was no significant difference in student success when students were taught by a software versus a teacher. Since the two teaching methods have been shown to be equally effective, computer software is the preferred method of keyboarding instruction as it allows the teacher to play a support role in the keyboarding instruction process and better monitor students' keyboarding techniques (Olinzock, 1998). Common free web-based keyboarding education programs include Dance Mat Typing (BBC, 2016), TypingClub (TypingClub, 2016), and Type to Learn (Sunburst, 2014). These free-web based keyboarding programs provide students with the opportunity to practice keyboarding, receive immediate feedback, and monitor their performance. A hallmark of these programs is that they have a stimulus-response feedback loop, in which the student is prompted by the computer, enters their answer, and the computer tells them whether their answer was right or wrong (Niederhauser & Stoddart, 2001). These types of highly structured instruction formats may be effective at helping students develop keyboarding automaticity (Niederhauser & Stoddart, 2001). Weigelt Marom and Weintraub (2015) found that "Easy Fingers" software (Weigelt Marom & Weintraub, 2010), a touch typing instructional and keystroke logging program, improved typing speed and accuracy in students with and without learning disabilities. Regardless of the teaching method, keyboarding programs that contain sub-goals and allow students to experience intermediate steps

to success are the most effective, because student persistence is a major factor that has been found to underlie keyboarding success (Sormunen, 1993).

Keyboarding success by grade level. Research presents various measures of success for keyboarding skills for different grade levels. Success in keyboarding can either emphasize accuracy or speed. A generally accepted measure of success in keyboarding is to be at least as fast as handwriting (Connelly, Gee & Walsh, 2007; Freeman, MacKinnon, & Miller, 2005). It is difficult to determine keyboarding speed and accuracy norms for various grade levels because the instructional level needed to achieve various targeted speeds is still unknown (Freeman et al. 2005). An analysis and synthesis of 26 research studies measuring keyboarding speed in elementary school students illustrates the broad range of attained keyboarding speeds for each grade level; the studies examining keyboarding speed reported speeds ranging from 4.7-70 WPM for fifth graders and 7.1-30 WPM for fourth graders (Freeman et al. 2005). This synthesis illustrates how previous keyboarding research has produced a wide range of keyboarding WPM "norms" for each grade level, rendering it difficult to determine the target keyboarding speeds for each grade level. As a result of the variability in research regarding keyboarding speed, researchers suggest using handwriting speed as "a basis for estimating keyboarding speed targets" (Freeman et al., 2005, p. 123). A synthesis of 10 studies considering handwriting speed yields the following ranges for first through fifth grade, respectively: 3.5-4.1 WPM, 4.8-11 WPM, 5-11.2 WPM, 6.8-16.4 WPM, 7.6-16.6 WPM (Freeman et al., 2005). Since the range of handwriting speeds for each grade level is narrower, handwriting speed targets provide a useful reference for identifying keyboarding speed targets.

Motor Learning Theory and Keyboarding

Motor learning stages. Motor learning theory explains how individuals move through stages of learning to develop motor control though task-specific practice and feedback (Zwicker & Harris, 2009). Motor learning principles have been used in keyboarding instruction to help students develop fluency and automaticity (Stevenson & Just, 2014). There are three stages of motor learning described by Fitts and Posner (1967) that outline the progression of motor control acquisition. During the first stage, the cognitive stage, the individual may be familiar with the task but unfamiliar with how to perform the task and will have to use conscious effort to attend to the task requirements (Fitts & Posner, 1967). Thus, their performance will be highly variable with many errors and may require external feedback (verbal or physical cues) to perform the task properly (Fitts & Posner, 1967). At this stage, instruction is targeted to help learners develop a solid foundation for the desired skill. Regarding keyboarding, an individual may have some knowledge of keyboarding and its sequence but may be unable to execute the task without explicit instruction, cognitive attention, and visual feedback (Stevenson & Just, 2014). Therefore, instruction at this stage will require extensive practice and explicit teaching and feedback regarding pre-keyboarding exercises, letter identification, and hand positioning to build a proper foundation for keyboarding skills (Stevenson & Just, 2014).

In the second stage, the associative stage, individual's skills become more refined and with practice, performance becomes more consistent, and they make fewer errors (Fitts & Posner, 1967). The external support and feedback decreases as the individual becomes more reliant on internal feedback to guide their performance (Poole, 1991). This internal feedback results in implicit learning that ultimately helps promote skill generalization (Zwicker & Harris, 2009). At this stage, the keyboarder's performance and skills become increasingly refined and the individual starts to internalize the motor movements so that they can rely on internal

feedback to guide their performance. Instruction should adapt to the learner's progress and continue to challenge the learner in a just right manner to promote increased skill level. Individuals at this stage will use the home keys for touch typing, begin developing muscle memory for finger movements, use good technique to locate letters from the home keys (Freeman et al., 2005)

During the third stage, the autonomous stage, the individual's skills become automatic and internalized. The individual has learned the skill and uses less cognitive effort, specifically fewer attentional demands, to execute the skill (Fitts & Posner, 1967; Zwicker & Harris, 2009). At this stage, the individual does not have to designate as much cognitive effort to the motor control aspects of keyboarding as they have improved in kinesthesia/muscle memory necessary for locating keys. Thus, at this stage individuals can shift their cognitive resources to focus on the higher-level functions of the writing process, such as idea development, creativity, organization, and grammar. Additionally, at this stage, keyboarding speed continues to increase, and vision is used primarily to locate less frequently used keys or check for errors on the screen (Freeman et al., 2005)

Practice and feedback. Practice is one of the central tenets of motor learning theory, and there are many types of practice to consider when utilizing motor learning theory in practice. Research about practice in relation to motor learning theory has primarily been done with the adult population, but many of the findings with the adult population have also been documented in research with children (Zwicker & Harris, 2009). In general, distributed practice, which involves alternating rest and practice, has been shown to be more effective at contributing to motor learning than massed practice, which involves continuously practicing a task without rest (Zwicker & Harris, 2009). Research comparing the effects of blocked practice, which involves

repetitive practice on the same task, to random practice, which involves varying the task over practice trials, is inconclusive for the motor learning of the pediatric population (Zwicker & Harris, 2009). Finally, research suggests that while learning parts of a task is helpful during the early stages of learning, meaningful, whole task practice results in better movement quality (Peck & Detweiler, 2000; Ma & Trombly 2001). Similarly, for keyboarding, meaningful practice is a key for fluency and speed development (Stevenson & Just, 2014). Additionally, over-learning the foundational skills through meaningful practice is necessary before introducing speed (Cunningham Amundson, 1992; Peterson & Nelson, 2003).

Feedback is another important tenet of motor learning and is defined as information that is provided to the individual about their performance of a task (Zwicker & Harris, 2009). Feedback can be defined in terms of extrinsic and intrinsic feedback. Extrinsic feedback is any information that the individual receives from their external environment, and this feedback forms the basis for explicit learning (Gentile, 1998; Shumway-Cook & Wollacott, 2001). Examples of explicit feedback include verbal directions, physical guidance, and demonstrations by an outside source. Sporadic feedback, which is feedback after some, but not all trials, after a delay has been shown to be the most effective to improve motor learning for adults as it teaches the individual how to determine what factors are influencing their performance rather than relying on external feedback (Schmidt, 1991; Winstein & Schmidt, 1990). In contrast, children have been shown to acquire motor skills better when provided with feedback 100% of the time during the movement being performed (Sullivan, Kantak, & Burtner, 2008). Intrinsic feedback is information provided to the individual by their sensory systems (ie. kinesthesia/muscle memory) because of movement, and it forms the basis for implicit learning, which is not under conscious control (Gentile, 1998; Shumway-Cook & Wollacott, 2001). Ultimately, the goal of motor learning

interventions is fade out extrinsic feedback and promote the individual's use of intrinsic feedback; in this way, the individual will be able to self- monitor performance rather than rely on outside sources to guide them, which will ultimately free up cognitive resources.

Keyboarding Without Tears

Keyboarding Without Tears is a touch-typing program that uses game-based, grade-appropriate lessons that incorporate concepts from various school subjects to build touch keyboarding fluency (Keyboarding Without Tears, 2016). The curriculum features pre-keyboarding and keyboarding lessons, digital citizenship lessons, and general computer readiness. The lessons are student-directed and progress by grade level and developmental needs. Keyboarding Without Tears recommends that educators use the program 5-10 minutes a day or 30 minutes per week (Keyboarding Without Tears, 2016).

Although educators recognize the importance of keyboarding, a "touch typing curriculum has not systematically been implemented into U.S. schools" (Poole & Preciado, 2016, p.3). This lack of execution may be because the system has not seen enough benefit to justify the costs of implementing a program in schools. Therefore, it is important to replicate research about the benefits of touch typing curriculums and put pressure on the educational system to make a change. Thus, the purpose of this study is to determine the effectiveness of Keyboarding Without Tears and provide more evidence about the type of keyboarding curriculum that will be most effective for and provide the most benefits to elementary school students. This research will be a step to help progress typing education forward. This research will also be very useful to determine if using keyboarding applications for a second year further develops keyboarding skills as prior research has suggested.

The primary research questions are: (1) how does the change in net WPM, for students who used KWT for two years, compare to that of students who used free web-based activities as instruction in the first year and used KWT in the second year? (2) for grades one through five, how does the change in keyboarding technique, for students who used KWT for two years, compare to that of students who used free web-based activities for the first year and used KWT for the second year? The research hypotheses are: (1) for grades one through five, students who have used the KWT program for two years will have a significantly greater improvement in net WPM than those who participated in free web-based activities for the first year and used the KWT program for the second year and (2) for grades one through five, students who used the KWT program for two years will have a significantly greater improvement in keyboarding technique than those who participated in free web-based activities for the first year and used KWT for the second year, as measured by higher numerical scores (1 is the lowest, 5 is the highest) on the keyboarding technique observation.

The secondary research questions are: (1) for grades one through five, is there an improvement in net WPM for students who used KWT for 2 years and students who participated in free web-based activities for the first year and used KWT for the second year? (2) for grades one through five, is there an improvement in keyboarding technique for students who used KWT for 2 years and students who participated in free web-based activities for the first year and used KWT for the second year? The secondary research hypotheses are: (1) for grades one through five, all students who received keyboarding instruction will experience an increase in net WPM (2) for grades one through five, all students who received keyboarding instruction will experience improvement in keyboarding technique.

CHAPTER 3: METHODOLOGY

Design

The following is a quasi-experimental pre-test-post-test study design that compared the effect of two different keyboarding instructional approaches on students' net keyboarding WPM and keyboarding technique over a 2-consecutive-year period. The independent variable in this study was the length of time that the school used Keyboarding Without Tears (KWT) as an intervention tool for its students. Madison Avenue Elementary and Madison Avenue Upper Elementary schools used the KWT program for two years, whereas Mannsdale Elementary and Mannsdale Upper Elementary used the KWT program only in the second year of the study (2017-2018). Mannsdale Elementary and Mannsdale Upper Elementary participated in free web-based activities, common practice for this school district, during the first year of the study. The students included in this study were in first through fifth grade during the second year of the study (2017-2018), and thus were in kindergarten through fourth grade during the first year of the study (2016-2017). Students in this study are referred to by their grade level in the second year (2017-2018) of the study. Using this pool of students allowed researchers to gather data on students that were enrolled in the schools over a two-year period, and thus analyze the long-term effects of using the KWT program for two years compared to using free web-based activities the first year and KWT the second year. The first through fifth grade students in Madison Avenue Elementary and Madison Avenue Upper Elementary schools are referred to as the KWT group, and the first through fifth grade students at Mannsdale Elementary and Mannsdale Upper Elementary are referred to as the mixed keyboarding instruction group. The two dependent variables are net WPM and keyboarding technique of students. Researchers examined whether

students in the KWT group had a greater change in net WPM and keyboarding technique than students in the mixed keyboarding instruction group.

Participants

The subjects included students in four elementary schools in Madison County Mississippi that were gathered through convenience sampling. According to the US Census Bureau (2017), the racial demographics of Madison County, Mississippi are: 57.6% White, 38.2% African American, 3% Hispanic, 2.7% Asian, and 0.3% American Indian. In comparison, in the United States as a whole, 76.6% of residents are White, 13.4% are Black, 18.1% are Hispanic, 5.8% are Asian, and 1.3% are American Indian (United States Census Bureau, 2017). In Madison County, 7.1% of residents have a disability, the median household income is $65,924, and 12% of residents live in poverty (United States Census Bureau, 2017). In the United States, 8.6% of residents have a disability, the average household income is $57,617, and 12.7% of residents live in poverty (United States Census Bureau, 2017).

The KWT group had 600 students complete Typing Test 1, 601 students complete Typing Test 2, and 618 students scored on keyboarding technique at both pre-test and post-test, and thus these were the data analyzed. The KWT group was comprised of students in first through fifth grade at these schools during the 2017-2018 school year. The mixed methods group had 725 students complete Typing Test 1, 719 students complete Typing Test 2, and 771 students scored on keyboarding technique at both pre-test and post-test, and thus these were the data analyzed. The mixed keyboarding instruction group is made up of students that were in first through fifth grade at these schools during the 2017-2018 school year.

The inclusion criteria for this study includes children of all genders and ethnicities who were grades one through five during the second year of the study and who regularly participated in the weekly computer lab class at the school.

The exclusion criteria for this study includes those students that did not wish to participate in the study, students who did not complete both the pre-test and post-test sessions, students who did not regularly participate in the computer lab class, and students whose parents chose to opt out of the study. Additionally, students that repeated their grade from the first year of the study were excluded. There were no students that did not wish to complete the study, nor were there any whose parents opted out of the study. Overall, in both groups combined, there were 503 students that either did not complete pre-test or did not complete post-test of Typing Test 1, 511 students that either did not complete pre-test or did not complete post-test of typing test 2, and 500 students that either did not receive a score for pre-test or did not receive a score for post-test for keyboarding technique observation, and thus these students were excluded from the study. The students that did not complete Typing Test 1 at either pre-test or post-test may or may not be the same students that did not complete Typing Test 2 or receive a keyboarding technique score at either pre-test or post-test, and vice versa, and thus the number of students excluded from each keyboarding measure cannot be aggregated to determine a total number of students excluded. These students missed receiving a score for the Typing Tests or keyboarding technique at either pre-test or post-test for a variety of reasons, some of which include these students were absent during the pre-test or post-test period, they moved or switched schools after the pre-test occurred, or they repeated a grade.

Instrumentation

There are no standardized assessments for keyboarding at this time. Thus, for this study, researchers used non-standardized outcome measures, one for speed and accuracy (net WPM) and another measure for keyboarding technique.

Typing test pro. Typing Test Pro (TypingMaster, Inc., 2016) was used at pre-test and post-test. It is an online tool for measuring keyboarding speed and accuracy that is customizable. For this study, the keyboarding sample was programmed to include: (1) a warm-up, which is a 1-minute keyboarding exercise at a first-grade reading level, to help get the children acclimated to using the program, (2) a 1-minute keyboarding exercise at a first-grade reading level, referred to as Typing Test 1, and (3) a 2-minute keyboarding exercise at a fourth-grade reading level, referred to as Typing Test 2. The warm-up data was not used for analysis. With this tool, students initiated each section of the assessment; when they started keying, the timer for that section started. Typing Test Pro measured gross WPM, accuracy percentage, and net WPM. Gross WPM measures the total words per minute keyed. The Typing Test Pro algorithm calculated this by dividing the total number of characters typed by five. The accuracy percentage measures the percentage of characters keyed correctly. The Typing Test Pro algorithm calculated this by dividing the number of correct characters keyed by the total number of characters keyed. Net WPM is a productivity measure that factors in both gross WPM and accuracy percentage. The Typing Test Pro algorithm calculated this by subtracting the number of word errors from the gross WPM. Higher numerical scores on this assessment indicate faster gross WPM, a higher accuracy percentage, and a faster and more accurate net WPM. Researchers selected this assessment tool for a few reasons. First, this assessment tool has also been used in previous research examining keyboarding skills, which provides support for the validity of this assessment tool (Barkaoui, 2014; Donica, Giroux, & Faust, 2018). Also, this assessment allowed researchers

to have control over the settings of the assessment and what was being keyed to better measure ability for children. Researchers created the text students keyed, disallowed backspacing, and controlled the duration of the program. Second, this assessment was convenient, as the gross typing WPM, accuracy percentage, and net WPM were immediately scored electronically which could be exported into Microsoft Excel for data analysis. Scores were also emailed to the lead researcher as a back-up.

Pre-test and expected post-test data forms. The pre-test and post-test data forms (see Appendix B and C) were the non-standardized assessment tools used to collect demographic information and record keyboarding technique during the pre-test and post-test periods for this study. They were used to determine if there was a change in keyboarding technique. This assessment and its corresponding scores were based on a 5-level scale of keyboarding technique used by Weigelt Marom and Weintraub (2010) in a study that looked to determine the keyboarding ability of higher education students. The scores on the assessment (1-5) correlate with the following abilities: (1) keying with one hand and one finger, and repeatedly using visual-feedback (i.e. visual guidance of keystrokes), (2) keying with two hands, using one finger on each hand, and repeatedly using visual-feedback, (3) keying with two hands, using two to four fingers on each hand, and repeatedly using visual-feedback, (4) keying with two hands, using all fingers of both hands, and repeatedly using visual-feedback, (5) keying with both hands, using all fingers, while looking at the monitor (and relying on kinesthetic feedback) (Weigelt Marom & Weintraub, 2010). Higher numerical scores on this assessment indicate a more advanced level of keyboarding technique. Researchers chose this assessment tool as it has been used in previous keyboarding research to determine keyboarding technique and identifies a process for measuring

an important component of keyboarding skill that does not have any other measure identified in literature.

Researchers were trained on keyboarding technique measurement using this scale prior to the pre-test and post-test assessments and performed inter-rater reliability measures to ensure reliability in scoring. The pre-test and post-test data forms (see Appendix B and C) also gathered information about the student's dominant hand and whether the student had a tablet, desktop computer, or laptop at home. These questions were included because students who have more practice with keyboarding at home, due to the presence of one of these devices, typically perform better on keyboarding related tasks in school (Barkaoui, 2014). Gathering information about each student's access to devices at home allows researchers to have a possible way to explain differences in students' starting keyboarding ability and to gather additional data regarding the correlations that exist between the presence of a device at home and keyboarding ability. These correlations will not be explored in this study but may be addressed in future research done with this data.

Interventions

Keyboarding Without Tears. KWT is a touch-keyboarding program that uses age-appropriate, game-based, and cross-curricular activities to build touch-keyboarding speed and fluency (Keyboarding Without Tears, 2016). While keyboarding speed is the rote WPM at which an individual keyboards, keyboarding fluency includes speed, technique, and overall foundational understanding and familiarity with keyboarding. The program progresses at the pace of the student, which helps individual students develop keyboarding skills at their own pace. The program has a developmentally-based sequence of games, awards, and checkpoints for motivation and to ensure the student is progressing through the program.

This tool was as the intervention method for the KWT schools for both years of the study and was used by the students at the mixed methods schools for the second year of the study only. Based on when the pre-test and post-test were conducted, during the first year of the study, students at the KWT schools used the program for up to 27 weeks. Similarly, during the second year of the study, students at the KWT schools and mixed method schools used the program for up to 31 weeks. At each school, and for each grade, KWT was used during the students' computer class which was held once per week and lasted for varying times. Specifically, at Madison Avenue Elementary, computer class lasted 45 minutes for students in kindergarten and first grade and 60 minutes for students in second grade. Computer class at Mannsdale Elementary (K-2nd grade) lasted for 30 minutes. Computer class for students at Madison Avenue Upper Elementary and Mannsdale Upper Elementary (3rd-5th grade) lasted 45 minutes. For both the KWT schools and the mixed method schools, it is important to note that the KWT curriculum was carried out in addition to a variety of other computer-based activities, and thus students may not have completed KWT activities for the entire class session each week.

KWT licenses are available for each grade level (K-5), and in this study, students received a KWT license for their respective grade. The KWT program uses motor learning principles to progress students through the motor learning stages and ultimately enables them to develop success in keyboarding. The kindergarten and first grade programs are based on the cognitive stage of motor learning, and thus the instruction involves repetitive practice that introduces these students to keyboarding and developing foundational skills for the task. "Keys for Me" is the kindergarten student program that prepares students for keyboarding using games that develop fine motor skills, introduce keyboard and mouse functions, and reinforce

handwriting skills. “My Keying Board” is the first-grade program that utilizes game-based tools to improve finger dexterity, finger-key association, and keying of letters and words.

The second and third grade programs are based on the associative stage of motor learning, and therefore developing students’ muscle memory. In these grades, the KWT games become more difficult as students’ skills become more refined. “Key Power” is the second-grade student program that uses games to develop muscle memory for keyboarding. During this program, students practiced common letter combinations and frequently used short words and sentences. “Keyboarding” is the third-grade student program that starts with a review and mastery of the second-grade program and then quickly progresses to addressing number and function keys, formatting, and writing paragraphs. This program focused on reinforcing students’ fine motor skills, muscle memory, and accuracy.

The fourth and fifth grade program instruction is focused on helping students move from the associative stage of motor learning to the automatic stage. Therefore, initially instruction is focused on further refining students’ muscle memory for the keyboarding strokes, but once this muscle memory has developed, games allow students to practice and develop cognitive skills needed for of the writing process in addition to keyboarding. “Keyboarding Success” is the fourth-grade student program that used typing games to further strengthen muscle memory in frequently used combinations and keyboarding speed and fluency. Activities in this program were also targeted to enhance language arts and creative writing skills. “Can-Do Keyboarding” is the fifth-grade program in which games helped students develop the accuracy and speed necessary to handle the demands of schoolwork and testing in higher grades. This program also allowed students to have exposure to paragraph and creative writing (Keyboarding Without Tears, 2016). It is important to note that the KWT program progresses with each student’s

individual skill level and each grade level program is designed to move students through the motor learning stages at their own pace.

KWT has an optional introductory feature, called "Jump into Keyboarding" that, if used, orients students to the KWT program and foundational keyboarding skills for the first 6 weeks of the program (Keyboarding Without Tears, 2016). Figure 1 provides describes the usage of the Jump into Keyboarding feature throughout the study; The KWT schools both used the Jump into Keyboarding feature during the first year of the study but only the K-2 KWT school used it the second year. During the second year of the study, the mixed methods schools all used Jump into Keyboarding, just as the KWT schools did during their first year of exposure to the program. It is recommended, by the KWT company, for third through fifth grade students to skip "Jump into Keyboarding" if the students have had prior keyboarding instruction.

Each of the four schools had a different technology teacher who each used different reinforcement and teaching strategies. The computer teacher at Madison Avenue Elementary provides the K-2nd grade students with consistent positive reinforcement (stamps and tokens) for activity completion and home row usage. The Madison Avenue Upper Elementary computer teacher provides intermittent positive reinforcement during speed and accuracy checks for the 3rd-5th grade students. The Mannsdale Elementary and Upper Elementary also used reinforcement strategies but the details of these was unable to be determined.

Additionally, the KWT program provides educators with grade-appropriate lesson plans for teacher-led lessons. The lesson topics are: "Digital Citizenship", which includes lessons about common technology terms and internet safety; "Ready, Set, Row", which includes lessons about features of the keyboard; "Fingers & Keys", which includes incremental lessons about proper hand placement on the keyboard; and "Resources" which provides the teacher with

information about how to promote carryover of skills into the home environment, remediation tips, and technology standards. Per teacher report, the Madison Avenue Elementary and Madison Avenue Upper Elementary teachers used intermittent teacher-led lessons primarily during the second year of the study. Both computer teachers reported using a variety of grade appropriate "Digital Citizenship" and "Fingers & Keys" teacher-led lessons. Neither of the computer teachers at Mannsdale Lower or Upper used any of the KWT teacher-led lessons.

Supplemental computer-based activities. In addition to using the KWT program, teachers at all schools used incorporated supplemental keyboarding activities into the curriculum throughout the duration of the study. Per teacher report, Madison Avenue Elementary students used www.learning.com (Learning.com, 2018), which is a digital curriculum that focuses on teaching digital literacy, coding, and computer science at all grade levels, and www.code.org (Code.org, 2018), which is a digital curriculum for computer science, "very infrequently" throughout the second year of the study. The Madison Avenue Elementary computer teacher reported that she was required to use this program by the school. Madison Avenue Upper students were occasionally given free time to play computer and/or typing games from a list developed by the computer lab teacher. This computer lab teacher reports that www.cool-mathgames.com (Coolmath.com, 2018), a website with a wide variety of strategy, skill, and number games that primary develops students' mouse and cognitive flexibility skills, and www.nitrotype.com (Teaching.com, 2018), which is a racing game that allows students to practice their touch typing skills, were the two most frequently used sites by the students. At this time, researchers have been unable to obtain information about the supplemental computer-based activities used at either of the mixed method schools.

Free web-based activities. During the first year of the study (2016-2017), students at the mixed methods schools participated in free web-based keyboarding activities during their computer class, which was held once a week. Based on when the pre-test and post-test were conducted, during the first year of the study, students at the mixed method schools used the program for up to 27 weeks. The computer class at the lower school lasted for 30-minutes, and during this time, students were allowed to play interactive games on the PBS kids website (www.PBSkids.org) that promoted mouse and keyboarding skills (Public Broadcasting Service, 2017). The free web-based activities on this website varied depending on the students' grade. For example, students in kindergarten and first grade played games that taught mouse functions, such as click and drag, while second grade students played games that taught them the keys of the keyboard and keyboarding strokes.

The computer class at the upper school lasted for 45-minutes, and during this time students participated in a variety of computer activities. During computer class time, the computer lab teacher allowed students in third through fifth grade to participate in an online touch-typing program or taught lessons about Microsoft PowerPoint, coding, and keyboarding techniques for touch typing. The online touch-typing program utilized was Beginner Typing online typing lessons from Learn Typing© (http://www.learntyping.org), which teaches touch typing through activities, games, and tests (Holding, 2007). There are seven Beginner Typing lessons students can work through that progress from practicing typing letters, to groups of letters, to words, to sentences, to numbers and symbols. These lessons do not provide feedback when a student misspells a word or types incorrectly. Additionally, students often took speed typing tests online that measured keyboarding speed (WPM) and accuracy percentage (Groeber, 2017). Figure 1 depicts the interventions used at each school over the 2-year study period.

Figure 1

Interventions for each school in each year of the study

	Year 1 Intervention (August 2016-May 2017)	**Year 2 Intervention (August 2017-May 2018)**
Madison Avenue Elementary (KWT)	Jump into keyboarding + KWT	Jump into keyboarding + KWT
Madison Avenue Upper Elementary (KWT)	Jump into keyboarding + KWT	KWT
Mannsdale Elementary (Mixed Methods)	Free web-based activities	Jump into keyboarding + KWT
Mannsdale Upper Elementary (Mixed Methods)	Free web-based activities	Jump into keyboarding + KWT

Procedure

Figure 2 is an illustration of the timeline of this study. This figure indicates the grade levels that students were in during the first year of the study and their corresponding grade during the second year of the study. For example, students that were in kindergarten during the first year of the study were in first grade during the second year of the study. Only data for students who participated in the study for two years were included for analysis, as is depicted in this figure. East Carolina University's Institutional Review Board pre-approved the research IRB # UMCIRB 16-000531 (See Appendix A for approval letter).

Figure 2

Intervention Timeline

KWT Group: Madison and Madison Avenue Upper Elementary

August 2016: Pretest		May 2017	Summer	August 2017		May 2018: Post-test
Kindergarten	Intervention: KWT	Kindergarten	→	1st grade	Intervention: KWT	1st grade
1st grade	Intervention: KWT	1st grade	→	2nd grade	Intervention: KWT	2nd grade
2nd grade	Intervention: KWT	2nd grade	→	3rd grade	Intervention: KWT	3rd grade
3rd grade	Intervention: KWT	3rd grade	→	4th grade	Intervention: KWT	4th grade
4th grade	Intervention: KWT	4th grade	→	5th grade	Intervention: KWT	5th grade

Mixed Keyboarding Instruction Group: Mannsdale and Mannsdale Upper Elementary

August 2016: Pretest		May 2017	Summer	August 2017		May 2018: Post-test
Kindergarten	Intervention: Free web-based activities	Kindergarten	→	1st grade	Intervention: KWT	1st grade
1st grade	Intervention: Free web-based activities	1st grade	→	2nd grade	Intervention: KWT	2nd grade
2nd grade	Intervention: Free web-based activities	2nd grade	→	3rd grade	Intervention: KWT	3rd grade
3rd grade	Intervention: Free web-based activities	3rd grade	→	4th grade	Intervention: KWT	4th grade
4th grade	Intervention: Free web-based activities	4th grade	→	5th grade	Intervention: KWT	5th grade

The procedure for this study is as follows:

1. IRB authorization was approved.
2. Researchers were trained on how to use the KWT program and keyboarding technique measurement and completed an inter-rater reliability measure prior to participating in data collection.
3. In August 2016, each eligible student received an information form that described the study, which they took home to their parents. The form detailed how parents could opt their child out of the study if they did not want their child's data to be included in the study. Unless the parents chose to opt their child out, their child was enrolled to participate in the study and their data was included in the analysis if they met the remaining inclusion criteria.
4. Students at each school were coded based on their lunch number to ensure confidentiality. However, during the second year of the study, students were identified in the KWT program by their lunch number and first name as requested by

the teachers for ease in program use and approved by the IRB. However, the data collected for analysis still only used their lunch numbers.

5. Each school had one computer lab session per week for its students. Researchers went to all four schools and attended a computer lab session for each class in each grade in during August-September 2016 to conduct the pre-test. See Appendix D for detailed information about this process. Pre-test administration varied slightly from the document based on teacher preferences and time allotted for class. The level of involvement that the students had in the preparatory phase of administration (ie. filling out the pre-test data form and logging into the computer) varied slightly, but all students completed the Typing Test Pro in the same way.
6. At the end of each day of testing data from Typing Test Pro was exported (gross WPM, accuracy percentage, and net WPM) into a Microsoft Excel file. This data was then manually input into SPSS. Data from the pre-test form (Appendix B), including keyboarding technique, gender, hand preference, and computer devices at home were manually input into SPSS for each student based off of the recorded score during the pre-test period.
7. During the first year, each student in the KWT schools was assigned a grade appropriate license for using the KWT program in computer lab only. Students at the Mixed Instructional Method schools participated in free web-based keyboarding activities. These activities were completed during their regularly scheduled computer lab classes.
8. Throughout the school year, it was planned that students at Madison Avenue Elementary and Madison Avenue Upper Elementary would use the KWT activities

every time they had a computer lab class. A computer lab teacher for Madison Elementary and Madison Upper Elementary school proctored the students' use of the KWT program during the class time. On average, students participated in the KWT typing program once a week for up to 30 to 45 minutes depending on their schedule to receive lab time. Students at Mannsdale Elementary and Mannsdale Upper elementary participated in free web-based activities in their computer class once a week during the 2016-2017 school year. For both schools, various conflicts, such as school play rehearsal, holidays, and technical difficulties, prevented students from attending their computer lab class or using their keyboarding program during some weeks of the school year.

9. Throughout the 2017-2018 school year, students at all four schools used the KWT program regularly in computer lab class.
10. Researchers went to all four schools in May 2018. The post-test administration was conducted in similar way to the method used in the pre-test in step 5 (See Appendix D).
11. At the end of each day of testing Typing Test Pro data was exported (gross WPM, accuracy percentage, and net WPM) into a Microsoft Excel file. This data was then manually input into SPSS. Data from the post-test form (Appendix C) including keyboarding technique and satisfaction questions were manually input into SPSS.

Data analysis

Following the pre-test and post-test, all data was collected and organized into the tables seen in Chapter 4. The results were organized and analyzed based on the research questions. Data from pre-test and post-test net WPM and keyboarding technique were entered into IBM

SPSS Statistics Version 24 for statistical analysis. Nonparametric statistics were used for data analysis given that not all of the data met the normality assumption necessary for parametric statistical analysis. To compare the pre- to post-test change in net WPM and keyboarding technique between groups for each grade over the two-year intervention period, a Wilcoxon rank test was used. To determine this two-year intervention effect, data analysis included pre-test and post-test net WPM and keyboarding technique data from students at each school who were in grades 1-5 for the 2017-2018 school year. To test for significant change within each grade for each school, a Wilcoxon signed rank test was used on pre-test and post-test scores. Data, in Chapter 4, is presented in numerical summaries (mean, standard deviation, median, lower quartile, upper quartile) and bar graphs. Once all data was organized accordingly, conclusions were formulated about the efficacy of the two interventions, which can be seen in Chapter 5.

CHAPTER 4: RESULTS

Demographics

Table 1 summarizes the demographic information for the study participants, organized by group and grade. Students in Table 1 and throughout Chapter 4 and 5 are referred to by their grade in the second year of the study. As can be seen in the table, participants in each group and in each grade had similar demographic characteristics in the areas of race, gender, and special education status, which improves the reliability and validity of the comparison between groups. This study is unique in that it maintained a large sample size over a two-year period, which improves the generalizability of the results.

Table 1

Demographic Data

	KWT Group N (%) N=784	Mixed Methods Group N (%) N=968
First Grade	145 (18)	182 (19)
Race		
White	107 (77.5)	136 (78.2)
Black	22 (15.9)	26 (14.9)
Hispanic	3 (2.2)	2 (1.1)
Asian	6 (4.1)	10 (5.7)
Gender		
Boy	69 (49.6)	100 (54.9)
Girl	70 (50.4)	82 (45.1)
Special Education	28 (20.3)	15 (8.6)
Second Grade	139 (18)	190 (20)
Race		
White	105 (78.9)	136 (72.7)
Black	15 (11.3)	36 (19.3)
Hispanic	6 (4.5)	2 (1.1)
Asian	6 (4.5)	13 (7.0)

American Indian	1 (0.8)	0 (0)
Gender		
Boy	70 (50.4)	110 (57.9)
Girl	68 (48.9)	80 (42.1)
Special Education	25 (18.8)	21 (11.2)
Third Grade	160 (20)	207 (21)
Race		
White	117 (73.6)	142 (72.1)
Black	20 (12.6)	45 (22.8)
Hispanic	8 (5.0)	2 (1.0)
Asian	14 (8.8)	8 (4.1)
Gender		
Boy	83 (51.9)	107 (51.7)
Girl	77 (48.1)	100 (48.3)
Special Education	19 (12.0)	17 (8.6)
Fourth Grade	160 (20)	188 (19)
Race		
White	118 (75.2)	113 (75.8)
Black	27 (17.2)	27 (18.1)
Hispanic	6 (3.8)	5 (3.4)
Asian	6 (3.8)	4 (2.7)
Gender		
Boy	77 (48.1)	105 (55.9)
Girl	83 (51.9)	83 (44.1)
Special Education	18 (11.5)	11 (7.4)
Fifth Grade	180 (23)	201 (21)
Race		
White	138 (78.9)	136 (80.5)
Black	22 (12.6)	31 (18.3)
Hispanic	3 (1.7)	1 (0.6)
Asian	12 (6.9)	1 (0.6)
Gender		
Boy	94 (52.2)	98 (48.8)
Girl	86 (47.8)	103 (51.2)
Special Education	13 (7.4)	5 (3.0)

Change in Net WPM Between Groups

Tables 2 and 3 show the results of the Wilcoxon rank test comparing the median change in net WPM for Typing Test Pro (TypingMaster, Inc., 2016) test 1 and 2, respectively, between the KWT group and Mixed Methods group (MM) for students in each grade. As previously mentioned, at both pre-test and post-test students completed Typing Test 1, a 1-minute typing exercise at a first grade reading level, and Typing Test 2, a 2-minute typing test at a fourth grade reading level. Figures 3 and 4 provide a graphical illustration of the median change in net WPM between schools in each grade. Students in the KWT group had a significantly greater improvement in net WPM than the MM group in second grade ($p=0.01$) and third grade ($p<0.001$) for Typing Test 1, and in second grade ($p=0.01$), third grade ($p<0.001$), and fourth grade ($p=0.03$) for Typing Test 2. For each grade, except for first grade in Typing Test 1, the KWT group had a greater mean and median change in net WPM than the MM group.

Table 2

Net WPM Typing Test 1

	Pre M (SD)	Pre Mdn (Q1-Q3)	Post M (SD)	Post Mdn (Q1-Q3)	Change M (SD)	Change Mdn (Q1-Q3)	N	Wilcoxon signed rank test p value	Wilcoxon rank test p value
First									
KWT	0.02 (.14)	0 (0-0)	1.57 (1.55)	1 (0-2)	1.61 (1.57)	1 (0-2)	101	<.001*	0.18
MM	0.11 (.31)	0 (0-0)	1.41 (1.55)	1 (0-2)	1.40 (1.56)	1 (0-2)	138	<.001*	
Second									
KWT	0.62 (.83)	0 (0-1)	4.50 (3.41)	4 (2-6)	4.20 (3.26)	4 (2-6)	116	<.001*	0.01*
MM	0.74 (1.06)	1 (0-1)	3.82 (2.92)	3 (2-6)	3.18 (2.61)	3 (1-5)	137	<.001*	
Third									
KWT	1.94 (1.71)	2 (1-2.25)	9.54 (5.22)	9 (6-12)	7.76 (4.70)	7 (5-11)	119	<.001*	<.001*
MM	1.55 (1.89)	1 (0-2)	7.14 (4.023)	7 (4-9)	5.62 (4.06)	5 (3-8)	151	<.001*	
Fourth									
KWT	3.91 (3.31)	3 (1-6)	13.06 (6.41)	12 (9-16)	9.71 (10.62)	9 (5-12)	126	<.001*	0.168
MM	3.37 (3.16)	3 (1-5)	11.35 (5.92)	11 (8-15)	8.07 (4.92)	8 (5-11)	138	<.001*	
Fifth									
KWT	7.27 (4.26)	7 (5-10)	17.34 (7.22)	17 (13-21)	10.17 (6.56)	9.5 (6-14)	138	<.001*	0.189
MM	5.75 (3.85)	5 (3-8)	14.64 (6.15)	14 (11-18)	9.17 (6.27)	9 (5.5-12)	161	<.001*	

Note: *p<.05; M=Mean change; SD= Standard deviation; Mdn=Median

Figure 3

Median Change in Net WPM Typing Test 1

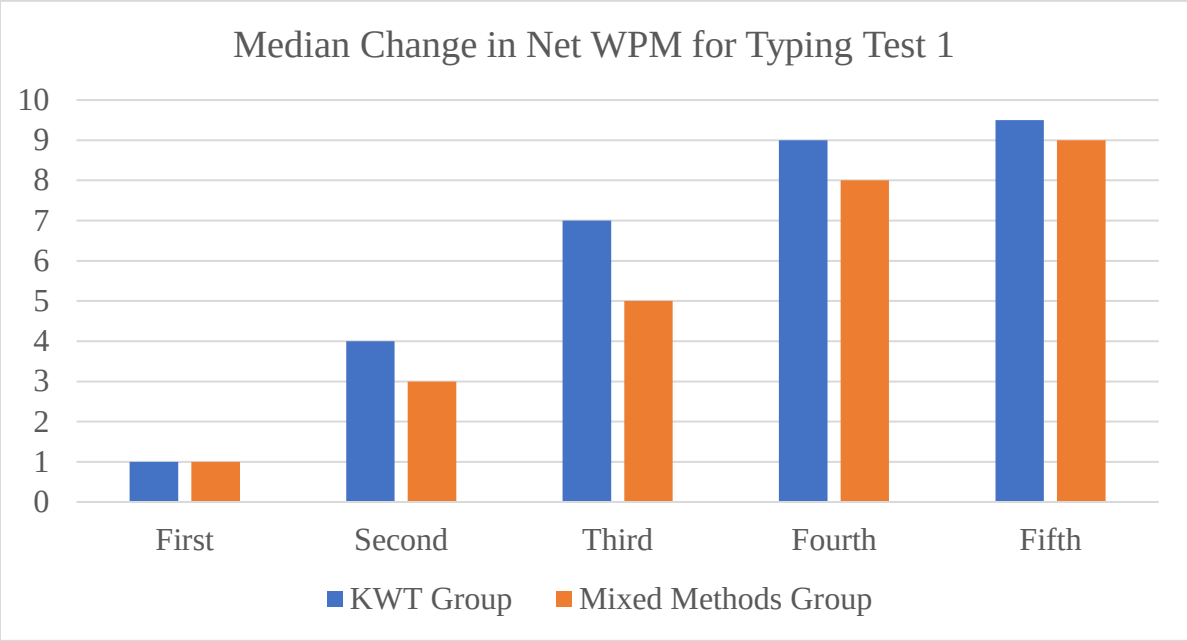


Table 3

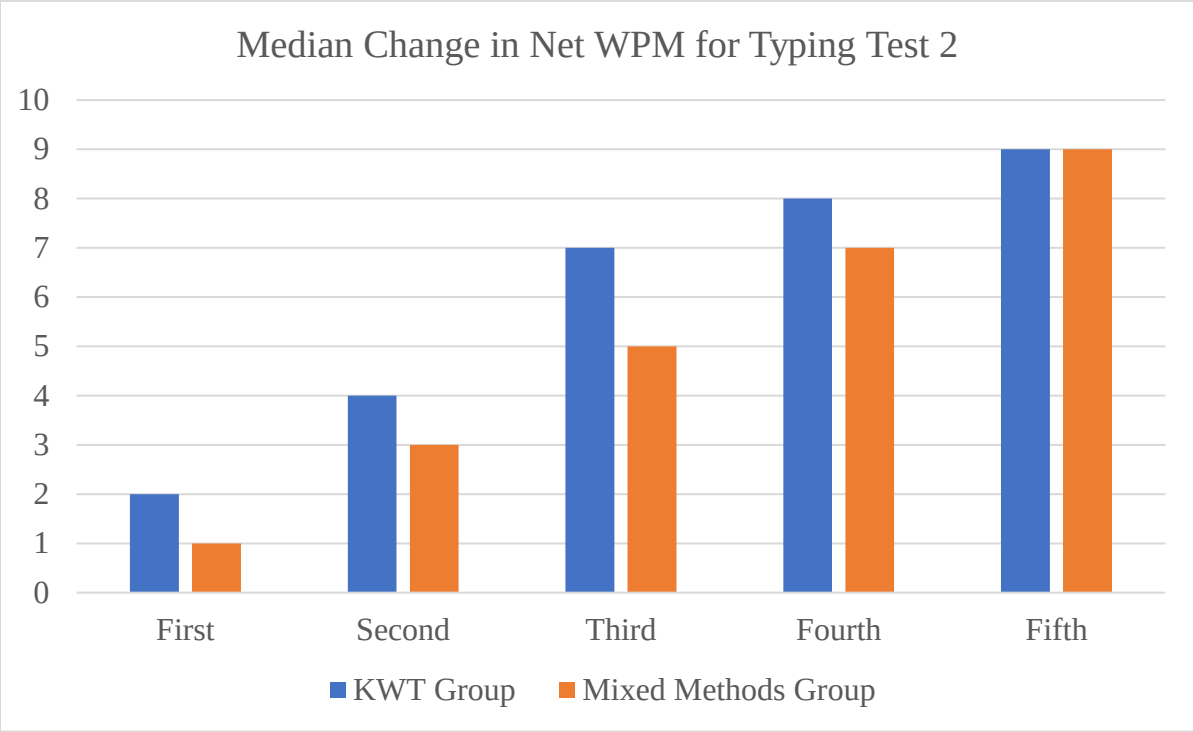
Net WPM Typing Test 2

	Pre M (SD)	Pre Mdn (Q1-Q3)	Post M (SD)	Post Mdn (Q1-Q3)	Change M (SD)	Change Mdn (Q1-Q3)	N	Wilcoxon signed rank test p-value	Wilcoxon rank test p-value
First									
KWT	0.03 (.29)	0 (0-0)	1.91 (1.91)	2 (0-3)	1.94 (1.79)	2 (0-3)	100	<.001*	0.07
MM	0.01 (.12)	0 (0-0)	1.56 (1.65)	1 (0-3)	1.60 (1.66)	1 (0-3)	137	<.001*	
Second									
KWT	0.43 (.86)	0 (0-1)	4.43 (2.42)	4 (3-5.75)	4.16 (2.24)	4 (3-5)	116	<.001*	0.01*
MM	0.56 (1.09)	0 (0-1)	4.08 (2.77)	4 (2-5)	3.50 (2.29)	3 (2-4)	138	<.001*	
Third									
KWT	2.12 (2.30)	2 (0-3)	9.59 (4.67)	9 (7-12)	7.30 (3.49)	7 (5-9)	119	<.001*	<.001*
MM	2.04 (2.10)	2 (0-3)	7.14 (3.59)	7 (5-9)	5.29 (3.47)	5 (3-7)	150	<.001*	
Fourth									
KWT	4.32 (3.11)	4 (2-6)	13.37 (6.35)	13 (10-16)	8.96 (5.37)	8 (5-11)	126	<.001*	0.03*
MM	3.92 (3.16)	4 (1-6)	11.37 (5.80)	11 (7-15)	7.60 (4.60)	7 (4-10)	134	<.001*	
Fifth									
KWT	7.84 (4.29)	8 (5-10.25)	17.61 (7.22)	16 (13-21)	10.02 (5.41)	9 (7-12.25)	138	<.001*	0.433
MM	6.33 (3.36)	6 (4-8)	15.18 (5.75)	15 (12-19)	9.31 (5.00)	9 (6-12)	160	<.001*	

Note: *p<.05; M=Mean change; SD= Standard deviation; Mdn=Median

Figure 4

Median Change in Net WPM Typing Test 2



A comparison of the change in Net WPM for second, third, and fourth grade, throughout the two years of the study can be seen in Table 4, below. These grades have been included in this table as they are the ones in which students in the KWT group experienced significantly greater median improvement in Net WPM than the MM group over the two-year intervention period, and thus a deeper analysis is warranted. This table illustrates the median change in Net WPM in year 1, the estimated median change in Net WPM for year 2 (ie. the difference between the overall median change and the year 1 median change), and the overall median change in Net WPM over the two-year study period for both groups. In this table, the Year 1 median change in Net WPM was calculated using Net WPM data from the start and end of year 1 of this study. This table illustrates that, during year 2 of the study, which is when all schools were using the KWT program, the median change in Net WPM for each grade at each school was greater than (or equal to for fourth grade KWT group) the median change during year 1 of the study. When considering Table 4, it is important to note that data regarding the amount of time spent on the program during each year of the study was not collected, and thus is unknown, but could be a confounding variable contributing to the various changes in Net WPM.

Table 4.

Estimated Yearly Change in Net WPM

	Year 1 Median Change (Q1-Q3)	Year 1 N	Estimated Year 2 Median Change	Overall Median Change (Q1-Q3)	Overall N
Second					
KWT	1 (0-3)	116	3	4 (2-6)	116
MM	0 (0-1)	137	3	3 (1-5)	137
Third					
KWT	2 (0-3)	119	5	7 (5-11)	119
MM	1 (0-3)	151	4	5 (3-8)	151
Fourth					
KWT	4 (1-6)	126	4	8 (5-11)	126
MM	2 (.75-4)	134	5	7 (4-10)	134

Change in Keyboarding Technique Between Groups

Table 5 shows the results of the Wilcoxon rank test that compared the median change in keyboarding technique between schools for each grade. As students were completing their typing exercises through Typing Test Pro at pre-test and post-test, researchers scored students' keyboarding technique on a scale from 1 (least advanced) to 5 (most advanced). Results from Table 5 indicate that students in the KWT group had significantly greater improvement in keyboarding technique than the students in the mixed methods group in every grade level; for all grades; ($p<0.001$), except fourth grade ($p=0.012$). Figures 5 and 6 provide graphical representations of the change in keyboarding technique scores for the KWT group from pre-test and post-test, respectively. Figures 7 and 8 provide graphical representations of the change in keyboarding technique scores for the mixed method group from pre-test to post-test, respectively. Data in these figures are shown by the percentage of students that achieved each

various level of keyboarding technique, which improves the comparability of the proportion of students that achieved each level of keyboarding between grades and groups. In these figures, blue represents a score of 1, or least advanced keyboarding technique, green represents a score of 2, tan represents a score of 3, purple represents a score of 4, and yellow represents a score of 5, or most advanced keyboarding technique. As these figures show, by post-test some students in third, fourth, and fifth grade in the KWT group earned a score of 5, while only a small fraction of students in fourth in the mixed methods group earned a score of 5.

Table 5.

Keyboarding Observation Results

	Pre M (SD)	Pre Mdn (Q1-Q3)	Post M (SD)	Post Mdn (Q1-Q3)	Change M (SD)	Change Mdn (Q1-Q3)	N	Wilcoxon signed rank test p value	Wilcoxon rank test p value
First									
KWT	1 (0.00)	1 (1-1)	2.58 (1.14)	3 (1-4)	1.72 (1.13)	2 (1-3)	105	<.001*	<.001*
MM	1.02 (.15)	1 (1-1)	1.43 (.55)	1 (1-2)	.42 (.58)	0 (0-1)	141	<.001*	
Second									
KWT	1.18 (.39)	1 (1-1)	3.33 (.90)	4 (3-4)	2.15 (.99)	2 (2-3)	120	<.001*	<.001*
MM	1.16 (.37)	1 (1-1)	1.72 (.55)	2 (1-2)	.57 (.64)	1 (0-1)	144	<.001*	
Third									
KWT	1.41 (.50)	2(1-2)	3.43 (.84)	4 (3-4)	2.05 (.96)	2 (2-3)	122	<.001*	<.001*
MM	1.41 (.51)	1 (1-2)	2.31 (.73)	2 (2-3)	.89 (.87)	1 (0-1)	161	<.001*	
Fourth									
KWT	1.88 (.69)	2 (1-2)	3.44 (.90)	4 (3-4)	1.62 (1.02)	2 (1-2)	129	<.001*	0.012*
MM	1.32 (.51)	1 (1-2)	2.67 (.77)	3 (2-3)	1.33 (.95)	1 (1-2)	153	<.001*	
Fifth									
KWT	2.06 (.68)	2 (2-2)	3.46 (.85)	4 (3-4)	1.46 (.99)	1.5 (1-2)	142	<.001*	<.001*
MM	2.31 (.71)	2 (2-3)	3.18 (.66)	3 (3-4)	.88 (.92)	1 (0-1)	172	<.001*	

Note: *p<.05; M=Mean change; SD= Standard deviation; Mdn=Median

Figure 5.

KWT Pre-test Observation Scores

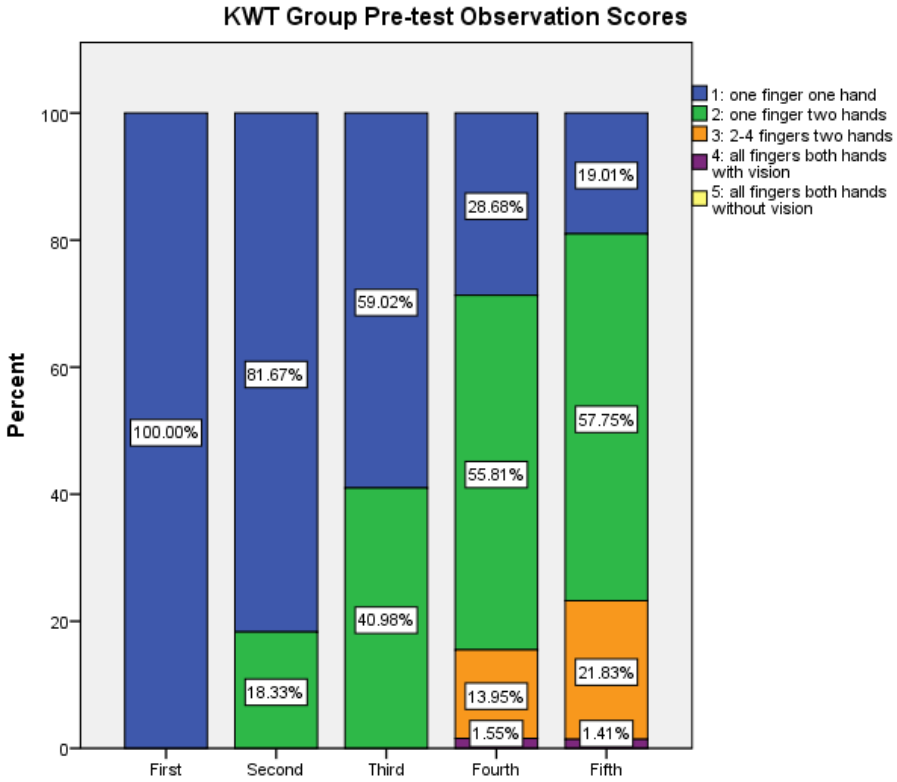


Figure 6.

KWT Post-test Observation Scores

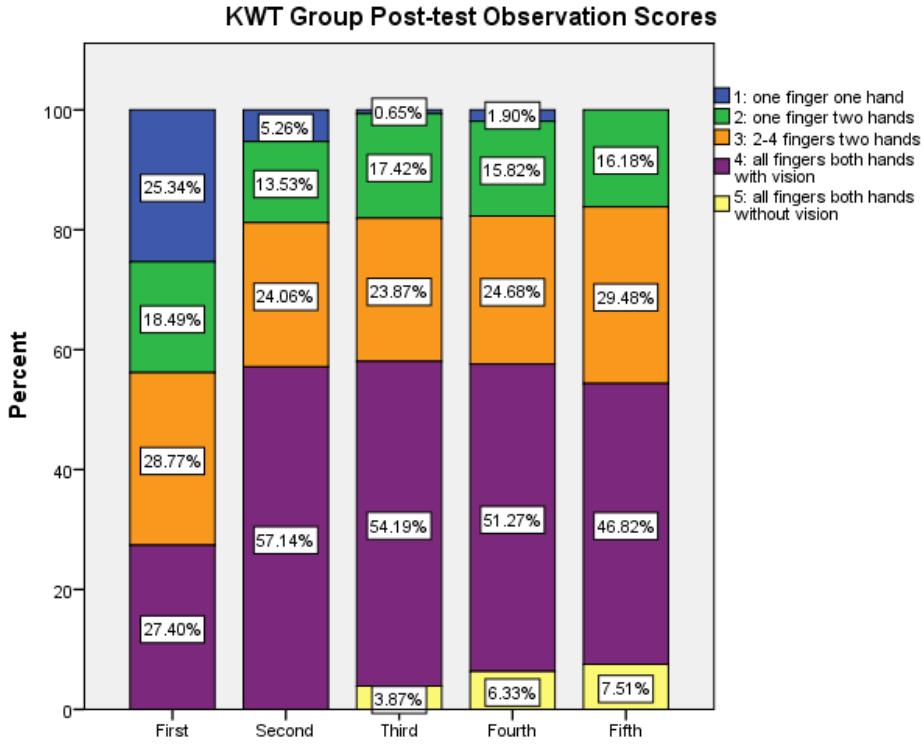


Figure 7

Mixed Methods Pre-test Observation Scores

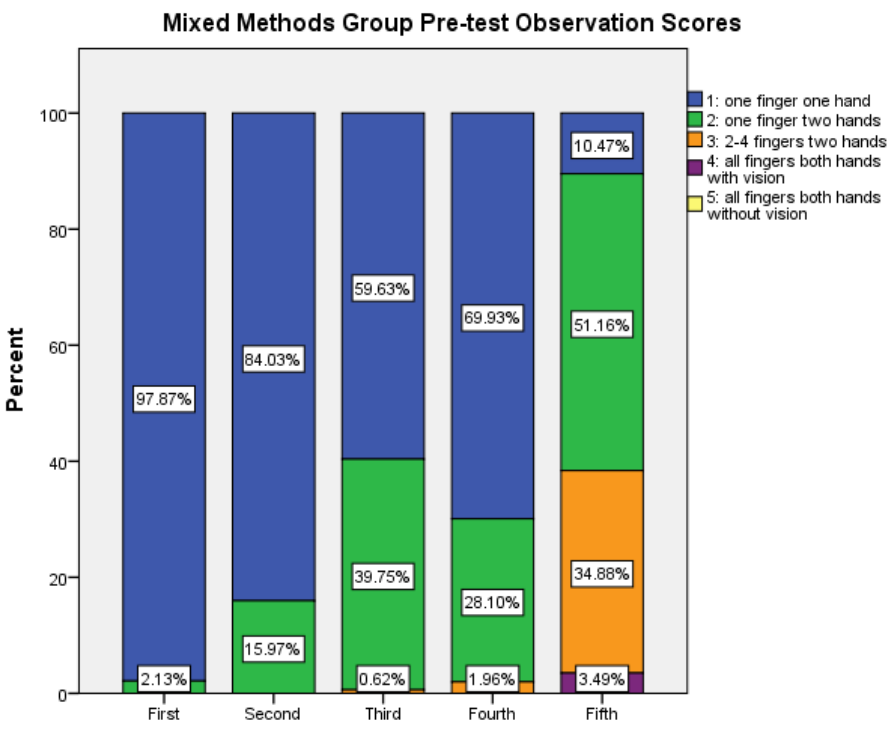
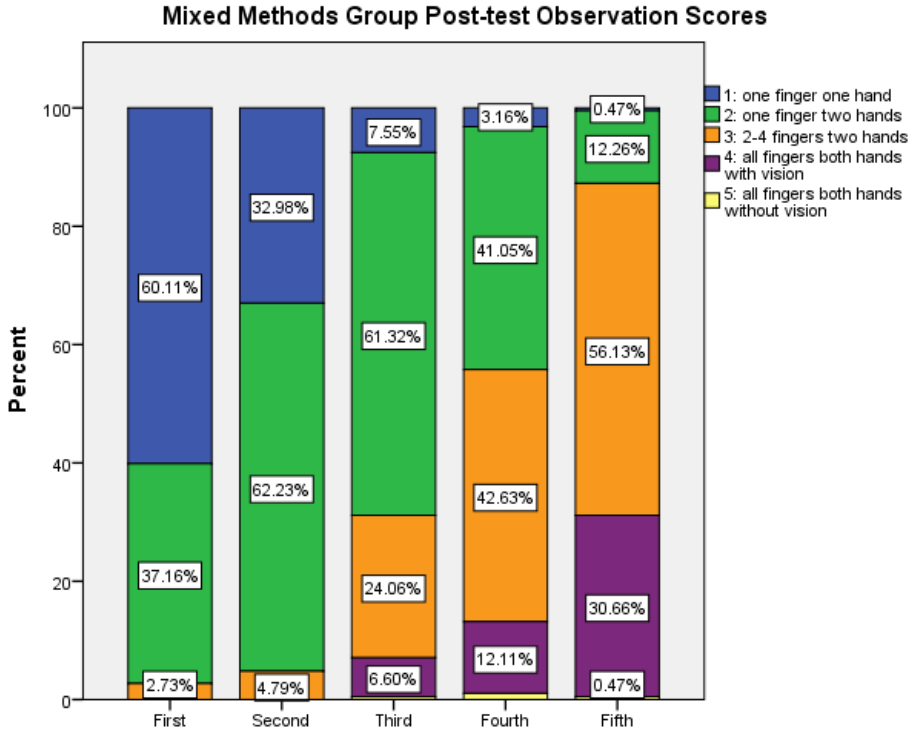


Figure 8

Mixed Methods Post-test Observation Scores



Net WPM and Keyboarding Technique Within Groups

Tables 2 and 3 provide the results of the Wilcoxon signed rank test examining the change in net WPM within groups for each grade. Results of this test show that students in all grades in both groups had significant improvement ($p<0.001$) in net WPM from pre-test to post-test as evidenced by performance on Typing Test 1 and Typing Test 2.

Table 5 provides the results of the Wilcoxon signed rank test examining the change in keyboarding technique within groups for each grade. Results of this test show that students in all grades in both groups had significant improvement ($p<0.001$) in keyboarding technique from pre-test to post-test.

CHAPTER 5: DISCUSSION

Change in Net WPM Between Groups

The results of this study indicate that implementing a structured keyboarding curriculum for students in elementary school leads to a greater improvement in net WPM than using a mixed methods approach to keyboarding intervention. For both typing tests, students in the KWT group demonstrated greater median improvement in net WPM than students in the MM group for each grade, except for first grade, in which the median change in net WPM was equal for Typing Test 1. Furthermore, for Typing Test 1, students in second and third grade had significantly greater improvement than students in the MM group in net WPM; and for Typing Test 2, students in second, third, and fourth grade in the KWT group had significantly greater improvement than students in the MM group in net WPM.

One possible reason for the significantly greater improvement seen in the KWT group in second, third, and fourth grade is the structure of the KWT program. As was previously mentioned, KWT has different licenses for each grade, and these licenses each have a different focus. The kindergarten license is not primarily focused on improving typing speed, but rather is focused on helping students develop foundational keyboarding skills, such as basic keyboard and mouse functions, as these skills are developmentally appropriate level for these students. Similarly, during the first year of the study, students in kindergarten in the MM group focused on these more basic, foundational keyboarding skills; and, then during the second year of the study, these students received the same KWT intervention as the KWT group. The fact that the KWT program is not targeted toward improving typing speed and that students in both groups received similar interventions for both years of the study may explain why students in first grade during

the second year of the study in the KWT group did not have a significantly greater improvement than students in the MM group.

In a similar way, the KWT license for fifth grade has more emphasis on developing the cognitive and higher-level skills needed for the writing process rather than developing keyboarding speed, as this is developmentally appropriate for these students preparing to enter middle school. While the fifth grade license does focus some on helping students develop typing speed, there is less of a focus on developing the muscle memory for keyboarding speed in this license than there is in the first through fourth grade license programs, which may explain why the fifth grade students in the KWT group did not have a significantly greater improvement than the students in the mixed methods group. KWT licenses for first through fourth grade strongly emphasized and focused on helping students develop muscle memory for increased keyboarding speed and fluency in a developmentally appropriate way for each individual student. In contrast, students in these grades in the mixed methods group participated in more generalized keyboarding speed and skill building activities during the first year of the study. The fact that students in the KWT group participated in an individually-tailored, developmentally appropriate program focused on developing muscle memory for improved keyboarding speed for two years may explain why the students in second, third, and fourth grade in the KWT group experienced significantly greater improvement than the students in the MM group.

Another possible reason for the significantly greater improvement seen in the KWT group in second, third, and fourth grade is that these students were of the age and developmental level that was most appropriate to benefit from the structured KWT program. Students in these grades are around the age at which much of past research suggests is the age at which students are likely to benefit most from a structured keyboarding program (Behymer & Echternacht,

1987; Chang, 1995; Freeman et al., 2005; Jackson & Berg, 1986; Kercher & McClurg, 1985; King & Alloway 1993; Tenney & Osguthorpe, 1990). Students in these grades entered the KWT program at a time in which they had not yet solidified foundational keyboarding skills, but at a time when they possessed the cognitive and motor skills to benefit from the program, and thus, especially benefitted from the developmental, motor learning approach that KWT used to help develop the skills of speed and technique.

As can be seen in Tables 2 and 3, while the KWT group had a significantly greater median change in Net WPM than the mixed methods group for second, third, and fourth grades, the difference between the median changes is 1 WPM, 2 WPM, and 1 WPM respectively. For example, in second grade, the median change in net WPM in the KWT group is 4 WPM, while the median change in net WPM for the mixed methods group is 3 WPM, which is a difference of 1 WPM between the two groups. One possible reason for this small difference in median change in WPM between the two groups is that students in the mixed methods group experienced a large improvement in WPM in the second year of the study, when they started using the KWT program. Had the students in the mixed methods group continued to utilize the less structured, free-web based activities as their intervention in the second year of the study, the difference between the median change in Net WPM between the two groups would have been much greater. However, the mixed methods group had to participate in the KWT program during the second year of the study as it would have been unethical to withhold with KWT program from the mixed methods group.

Table 4 provides estimates that support the suggestion that the MM group “caught up” to the KWT group during the second year of the study. As can be seen in Table 4, the estimated year 2 median change in Net WPM for both groups in each grade, except for the fourth grade

KWT group, is greater than the year 1 mean change in Net WPM. Table 4 suggests that the KWT program may have been more beneficial at improving the Net WPM of the students in the MM group than the free web-based activities, as these students experienced greater improvement during the second year of the study. Furthermore, this data could indicate that the students in the MM school began to "catch up" to the students in the KWT group once they began the KWT program, which would explain the small difference in the overall median change in Net WPM between groups. Additionally, Table 4 could suggest that using the KWT program for two years is beneficial, as students experienced improvements in Net WPM in each year of the study, and as in second and third grade, it is estimated that students improved more so in year 2 than they did in year 1.

Although previous research is not conclusive about which grade to begin typing education, many researchers agree that third grade or later is when keyboarding education should begin (Behymer & Echternacht, 1987; Jackson & Berg, 1986; Kercher & McClurg, 1985; King & Alloway 1993; Tenney & Osguthorpe, 1990). The results of this study indicate that starting a structured keyboarding curriculum in earlier grades is more beneficial than a mixed method approach, as over a two-year period, students in second and third grade during year 2 (first and second grade during year 1) experienced significant improvement in both net WPM and keyboarding technique from a structured keyboarding program, such as KWT, when compared to a mixed method approach to keyboarding instruction.

While most previous research (Behymer & Echternacht, 1987; Chang, 1995; Freeman et al., 2005; Jackson & Berg, 1986; Kercher & McClurg, 1985; King & Alloway 1993; Tenney & Osguthorpe, 1990) regarding when to begin keyboarding education indicates third grade or later, results from this study indicate that beginning a structured keyboarding curriculum at any time in

elementary school, even in kindergarten, will yield improvement in typing speed, just as Hoot (1996) concluded. Students in the KWT group demonstrated greater median improvement in net WPM than students in the mixed methods group in all grades (except first grade on Typing Test 1) on both Typing Test 1 and 2, indicating that it may be beneficial to beginning a structured keyboarding curriculum as early as kindergarten and continuing the program throughout elementary school.

A generally accepted measure of success in keyboarding is that it should be at least as fast as handwriting (Connelly, Gee & Walsh, 2007; Freeman, MacKinnon, & Miller, 2005). A synthesis of 10 studies considering handwriting speed yields the following ranges for first through fifth grade, respectively: 3.5-4.1 WPM, 4.8-11 WPM, 5-11.2 WPM, 6.8-16.4 WPM, 7.6-16.6 WPM (Freeman et al., 2005). At the end of this study, the average keyboarding speeds for first through fifth graders respectively were: 1.41-1.91 WPM, 3.82-4.50 WPM, 7.14-9.59 WPM, 11.35-13.37 WPM, 14.64-17.61 WPM. Thus, after two years of either a mixed methods or KWT keyboarding intervention, students in third, fourth, and fifth grade averaged higher keyboarding speeds than the average researched handwriting speeds. This indicates that, when using average handwriting speeds as a point of comparison, students that receive keyboarding education are able to achieve a successful and functional speed of keyboarding.

Change in Keyboarding Technique Between Groups

Results from this study also indicate that implementing a structured keyboarding curriculum in elementary school will yield significant greater improvements in students' keyboarding technique when compared to a mixed methods approach for every grade. When looking at the results in Table 5, it is important to note that, since the keyboarding technique data is ordinal data, a median change of 1 or 2, represents a more noteworthy change than a median

change of 1 or 2 WPM, as the WPM data is ratio data. So, while for each grade, the difference in median change between groups is ranges from 0.5-2, these may still be clinically significant improvements in keyboarding technique between groups.

One possible reason for the KWT group's significant improvement in keyboarding technique compared to the mixed methods group is the structure of the KWT program. In each grade level license, the KWT program strongly emphasizes using proper keyboarding technique (consistent with a keyboarding technique score of 4 or 5) through visual reminders within the program and increased repetitions with activities to promote more advanced technique. Conversely, most of the free web-based activities that the mixed methods group participated in during the first year did not emphasize proper keyboarding technique, and the only instruction provided about proper technique was from the keyboarding instructor intermittently throughout the year. The fact that the students in the KWT group received 2-year intensive instruction to promote improved keyboarding technique, whereas the students in the mixed methods received less structured and less prolonged keyboarding technique instruction, may have contributed to the KWT group's significantly greater improvement.

Another reason that the KWT group may have had significantly greater improvement than the mixed methods group is because of the environment. For both years of the study, each student in the KWT group had a visual reminder of the proper hand positioning for keyboarding on or above their computer. Additionally, the computer lab teacher for Madison Avenue Elementary (grades K-2) used positive reinforcement strategies when students utilized more advanced keyboarding technique, which may have improved their adherence to proper technique. Conversely, Mannsdale Elementary had three different computer lab teachers throughout the course of the second year of the study, so this inconsistent instruction may have negatively

impacted the consistency with which students were provided with reinforcement of keyboarding technique. Overall, it is likely a combination of the KWT program's focus on keyboarding technique and the environment that explains why students in the KWT group experienced significantly improved keyboarding technique compared to the mixed methods group.

As evidenced by the results of this study, elementary school students' keyboarding technique can be positively influenced by a structured curriculum in any grade. As expected, students in later elementary school achieved more advanced keyboarding technique, on average, than students in early elementary school for both groups. Of note, Figures 5, 6, 7, and 8 illustrate that, at post-test, students in the KWT group in first and second grade achieved more advanced keyboarding technique scores than students in first and second grade in the mixed methods group; 0% of students in these grades in the mixed methods group earned a technique score of 4, whereas 27.4% of students in first grade and 57.14% of students in second grade in the KWT groups earned a technique score of 4. These results further support beginning a structured keyboarding curriculum in early elementary school, as even children in first and second grade can develop relatively advanced keyboarding technique with structured intervention.

Net WPM and Keyboarding Technique Within Groups

While between group statistical analysis indicates that a structured keyboarding approach will yield more significant improvements in net WPM and keyboarding technique, the within group analysis also indicates that when students are provided with either typing curriculum, their skills will improve. The results of this research show that both methods of keyboarding intervention can significantly improve keyboarding technique. Additionally, the results suggest that students should begin a keyboarding curriculum as early as kindergarten and continue it through fifth grade, as students in each grade in both groups demonstrated significant

improvements in their keyboarding speed and technique over the course of the study. These results provide support for previous research (Sormunen, 1993) that indicates that regardless of the teaching method, some sort of structured curriculum or keyboarding education will lead to improvement in elementary school students' keyboarding ability.

Implications for Occupational Therapists and Teachers

The results of this study provide important information that can be used by occupational therapists, school administrators, and teachers. Occupational therapists in the school system play a large role in helping students improve performance in school-related occupations, which includes keyboarding. Occupational therapists have many roles regarding keyboarding in schools. Occupational therapists can help individual students who are having difficulty with keyboarding in school develop this skill to improve their success in this occupation. Occupational therapists can also provide keyboarding education as an alternative method of written expression for students who struggle with handwritten expression. Occupational therapists can also become an advocate and resource for implementing a keyboarding curriculum in schools as a school-wide Tier 1 intervention. As a part of this Tier 1 intervention implementation, occupational therapists could play a consultative role in which they educate teachers about the motor learning theory, its relationship to keyboarding skill development, and how to help students move through the motor learning stages to develop keyboarding fluency.

The results of this study indicate that, in general, using KWT as an intervention to help individual students improve their skills is more beneficial than using a mixed method approach at any grade level. Thus, regardless of the keyboarding curriculum that the school has adopted, occupational therapists may use a structured keyboarding curriculum, such as KWT, during individual treatment sessions with students who specifically need to develop keyboarding skills,

with students that need an alternative to handwriting, or with students that are struggling to improve their keyboarding skills with the school's current curriculum.

The results of this study also indicate that students' keyboarding skills can improve as a result of a variety of different intervention methods, as students in both the KWT group and mixed method group improved significantly over the duration of the study. Therefore, if a student is not succeeding in keyboarding with their school's chosen keyboarding curriculum, occupational therapists can use the results of this study as evidence supporting the use of an alternative approach to keyboarding intervention with the student.

For school districts and teachers, this study provides evidence for the benefit of implementing a keyboarding curriculum in elementary school, as early as kindergarten, as students in each grade experienced significant improvements in both keyboarding speed and technique. The results of this study show the positive impact that a keyboarding curriculum has on students' abilities. Although a structured keyboarding program such as KWT would yield greater improvement in skills according to the results of this study, if school districts and/or teachers do not have the funds to support a program like KWT for multiple years, using a mixed methods approach will still improve students' keyboarding abilities in any grade.

Recommendations for Future Research

Future research would benefit from comparing a structured keyboarding approach to a true control, or no keyboarding intervention, to fully explore the impact of a keyboarding intervention throughout the school year. This study was not structured with a true control, as researchers felt it would be unethical to deny the mixed methods group the KWT program.

Additionally, in the future, researchers should consider using and recording an objective measure of time spent using the keyboarding curriculum for each student in each group. This information would provide objective information about the impact that the dosage of keyboarding instruction has on skill improvement and insight into how much time students should spend using a keyboarding curriculum to see the greatest improvement in keyboarding related skills.

Other future research being done with the data collected in this study includes examining the correlation between reading level and keyboarding ability, comparing different keyboarding skill measurement tools, and examining the special education students' performance in each group.

Ethics

Researchers went through a variety of means to ensure ethical standards are upheld throughout the course of this study. Researchers gained IRB approval, coded students and their respective data to protect their identities, were trained to measure keyboarding technique, and secured all research paper files in a locked room.

Limitations of the Study

There were a few limitations in this study. The first limitation is the lack of randomization. The subjects were chosen and placed into groups based on the school they attend, and both schools are in the same region of Mississippi. The use of a convenience sample may decrease the level of control and internal validity of the study. The second limitation is that the study was completed in a small, rural part of Mississippi. Although the schools are diverse in terms of demographics, the schools are in a unique culture, thus the sample of students and their

performance data may not be representative of a typical elementary school student. The distinctiveness of the sample could cause the results to have less external validity, and thus be less generalizable to students in other parts of the country.

Another limitation of the study is that there was not a robust amount of information collected about the students. While researchers were able to obtain basic demographic data about the students (race, gender, and special education status), it would have been beneficial to collect data on socioeconomic status, academic performance (ex. Reading level) to help researchers understand the impact, if any, that these factors have on keyboarding speed and technique. Additionally, this data would have provided more information to ensure that the two groups were equivalent for comparison.

Another limitation is that researchers were unable to collect and analyze data regarding the dosage of each intervention. For example, researchers did not have objective information regarding the time spent on the KWT program, time spent on supplemental activities, and time spend of free web-based activities. While researchers know that each keyboarding class was held once per week, there is not specific information about how much each participant engaged in each treatment. This information may have allowed increased knowledge about the impact of the dosage of intervention necessary to elicit improved keyboarding skills.

Experimenter bias is another limitation of the study. This study requires experimenters to analyze typing technique based on 30-second to 1-minute observations of the child during the pre-test and post-test periods; thus, researchers were only able to get a very quick snapshot of students' typing technique. Additionally, typing technique is subjective in its nature, and students often combine and/or change typing techniques. To minimize this limitation, researchers were trained on how to assess keyboarding technique in a small window of time. This training

included an inter-reliability measure for keyboarding technique assessment to ensure consistency between raters. Although the researchers were trained to accurately assess a student's typing technique, experimenter variability in typing technique measurement may reduce internal validity of the data.

Finally, the assessment and intervention tools used are another limitation of the study. There are currently no standardized assessment or intervention tools for keyboarding in elementary schools, so the tools that were used in the study lacked reliability or validity measures. The use of unstandardized assessment measures may cause the results to have decreased reliability and/or validity. To minimize this limitation, the tools that used this study were chosen based on a thorough investigation of tools used in previous research. Researchers chose the Typing Test Pro and pre-test and expected post-test data forms because they can measure the dependent variables of interest, net WPM and keyboarding technique, for this research.

Conclusion

In the current technological era, students must develop keyboarding skills to be successful in school, work, and social occupations. The results of this study indicate that, either a mixed methods or structured keyboarding curriculum in elementary school would help to promote success in these areas of occupation. Furthermore, the results of this study indicate that a structured keyboarding program such as KWT is the more effective curriculum for improving students' keyboarding speed and technique, as students in the KWT group had a greater median improvement in these keyboarding skills than students in the mixed methods group in each grade, and improved significantly more than the mixed methods in students in second, third, and fourth grade. This study also provides evidence to support the implementation of a keyboarding

curriculum starting as early as kindergarten, as students in both groups demonstrated significant improvements in their keyboarding skills in every grade.

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APPENDIX A: IRB LETTER OF APPROVAL

EAST CAROLINA UNIVERSITY
University & Medical Center Institutional Review Board
4N-64 Brody Medical Sciences Building· Mail Stop 682
600 Moye Boulevard · Greenville, NC 27834
Office **252-744-2914** · Fax **252-744-2284** ·
www.ecu.edu/ORIC/irb

Notification of Continuing Review Approval: Expedited

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

Date: 3/28/2018
Re: CR00006790
UMCIRB 16-000531
Keyboarding Without Tears to Improve Keyboarding Skills of Children

The continuing review of your expedited study was approved. Approval of the study and any consent form(s) is for the period of 3/27/2018 to 3/26/2019. This research study is eligible for review under expedited category #9. The Chairperson (or designee) deemed this study no more than 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
Donica Management Plan(0.01)	COI Management Plan
Letter of support(0.01)	Dataset Use Approval/Permission
Parent Flyer - Summer Pilot(0.03)	Recruitment Documents/Scripts
Parent Flyer for Full Year(0.02)	Recruitment Documents/Scripts
Parent Letter Control Year 2 Updated(0.05)	Information Sheet
Parent Letter Control Year 2 Updated(0.05)	Consent Forms
Parent Letter Experimental Year 2 Updated(0.05)	Consent Forms
Parent Letter Experimental Year 2 Updated(0.05)	Information Sheet
Peter Giroux CITI Training(0.01)	Additional Items
Post-Test(0.04)	Standardized/Non-Standardized Instruments/Measures
Pre-Test(0.05)	Standardized/Non-Standardized Instruments/Measures
Summer Permission Form(0.02)	Consent Forms
Teacher/Staff Survey(0.02)	Surveys and Questionnaires
Teacher/Staff Survey(0.03)	Standardized/Non-Standardized Instruments/Measures
Updated KWT Proposal(0.04)	Study Protocol or Grant Application

The Chairperson (or designee) does not have a potential for conflict of interest on this study.

APPENDIX B: PRE-TEST DATA FORM

Please print your ID number: _____

Are you a: BOY or GIRL?

Circle what you have at home:

Laptop

Desktop

Tablet

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

For Researcher Use Only

Pre-Test Observation: 1 2 3 4 5

APPENDIX C: POST-TEST DATA FORM

Please print your lunch number: _____

Are you a: BOY or GIRL

Circle what you have at home:

Laptop

Desktop

Tablet

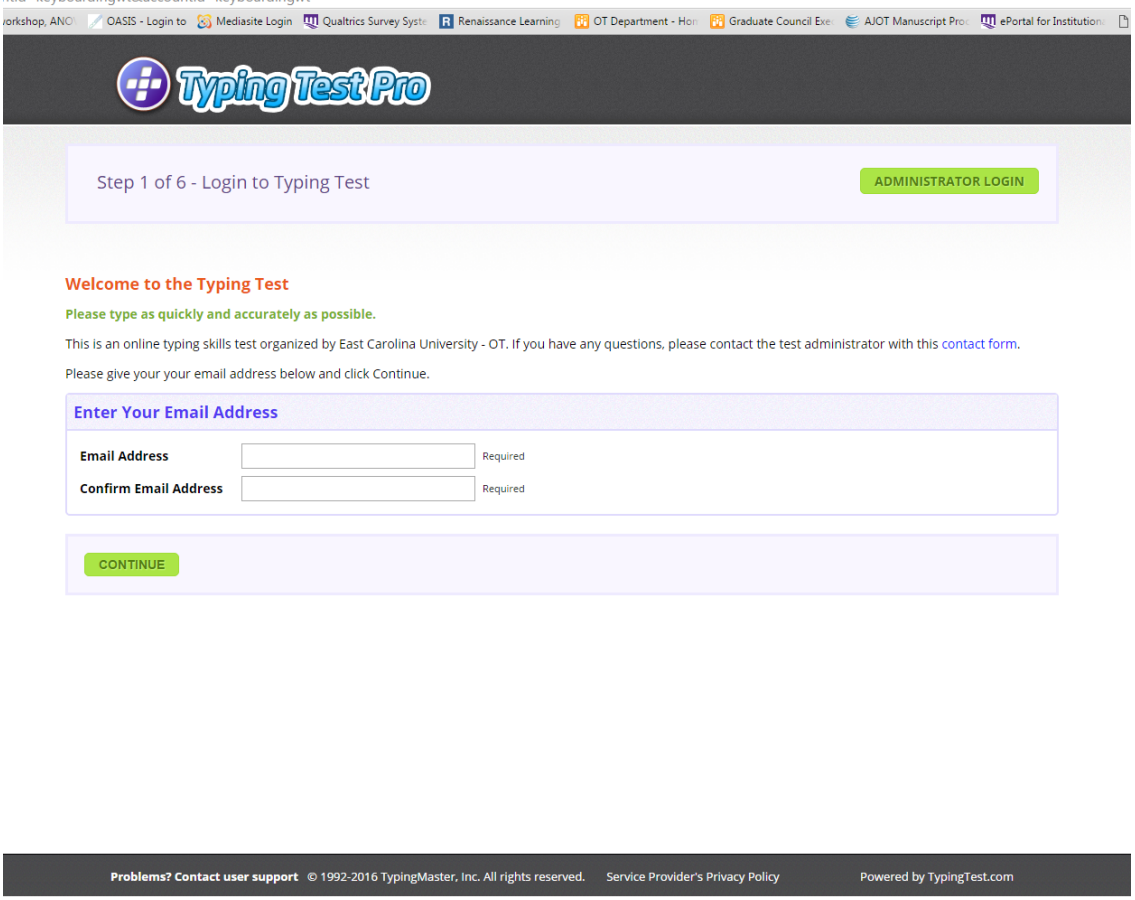
Circle your answer.

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

APPENDIX D: PRE-TEST INSTRUCTIONS

Prior to Keyboarding Assessment:

1. Open the internet to the following link:
   Madison Avenue Schools: http://keyboardingwt.typingtestpro.com
   Mannsdale Schools: http://kwtcontrol.typingtestpro.com



Keyboarding Assessment:

1. Have all of the computers set up to the screen above under “Prior to Keyboarding Assessment”
2. When children come into lab and sit down, introduce yourself and state

   “Today we want us to show you what you have learned this year with your keyboarding skills. Today, we are going to learn some information about you. Please wait to do anything until I have given you directions.”

3. Distribute “Post-Test Data Collection Form” one to each child and pencil if necessary.
   a. Ask the child to print their “LUNCH NUMBER” at the top of the page.
   b. Ask the child to circle BOY if they are a boy and GIRL if they are a girl.
   c. Ask the child to circle ALL devices are in their home (they do not need to belong to the child). They may circle more than one.

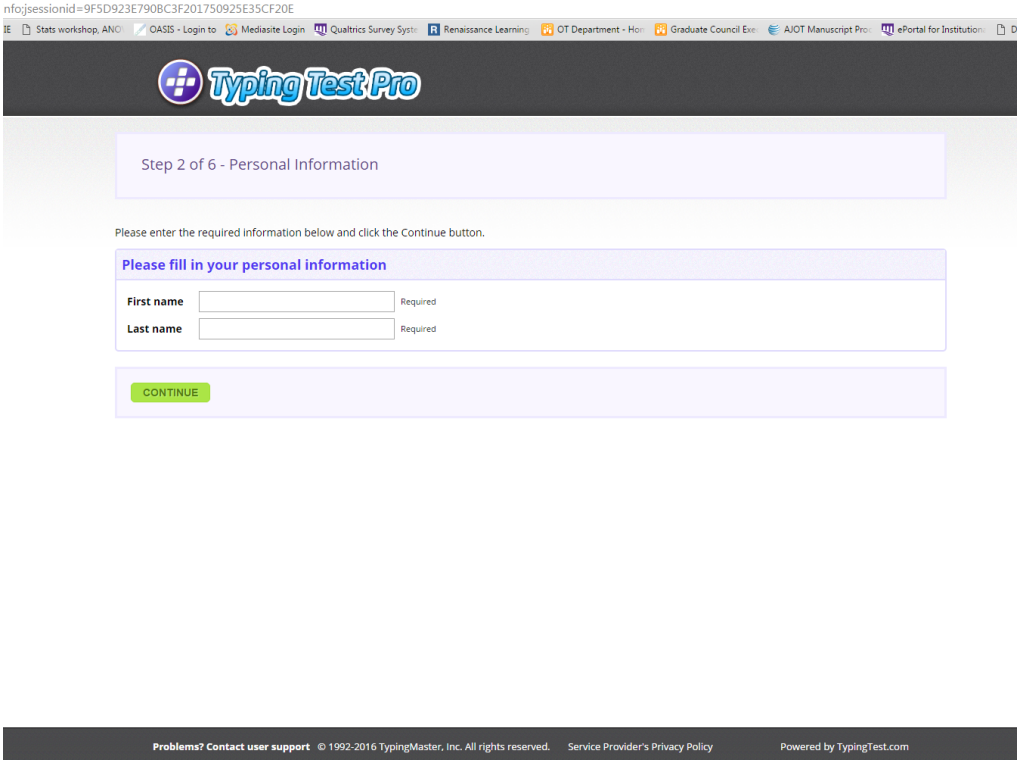
d. Ask the child to circle which hand they write with. They should be able to determine which picture of the hand is holding the pencil if they hold their hands out in front of them.

e. Read each of the 3 questions (Yellow, Green, and White) and ask the child to put an X in ONE box that applies to how often they do those things. You may elaborate or give examples of time-frames if necessary, especially for younger children.

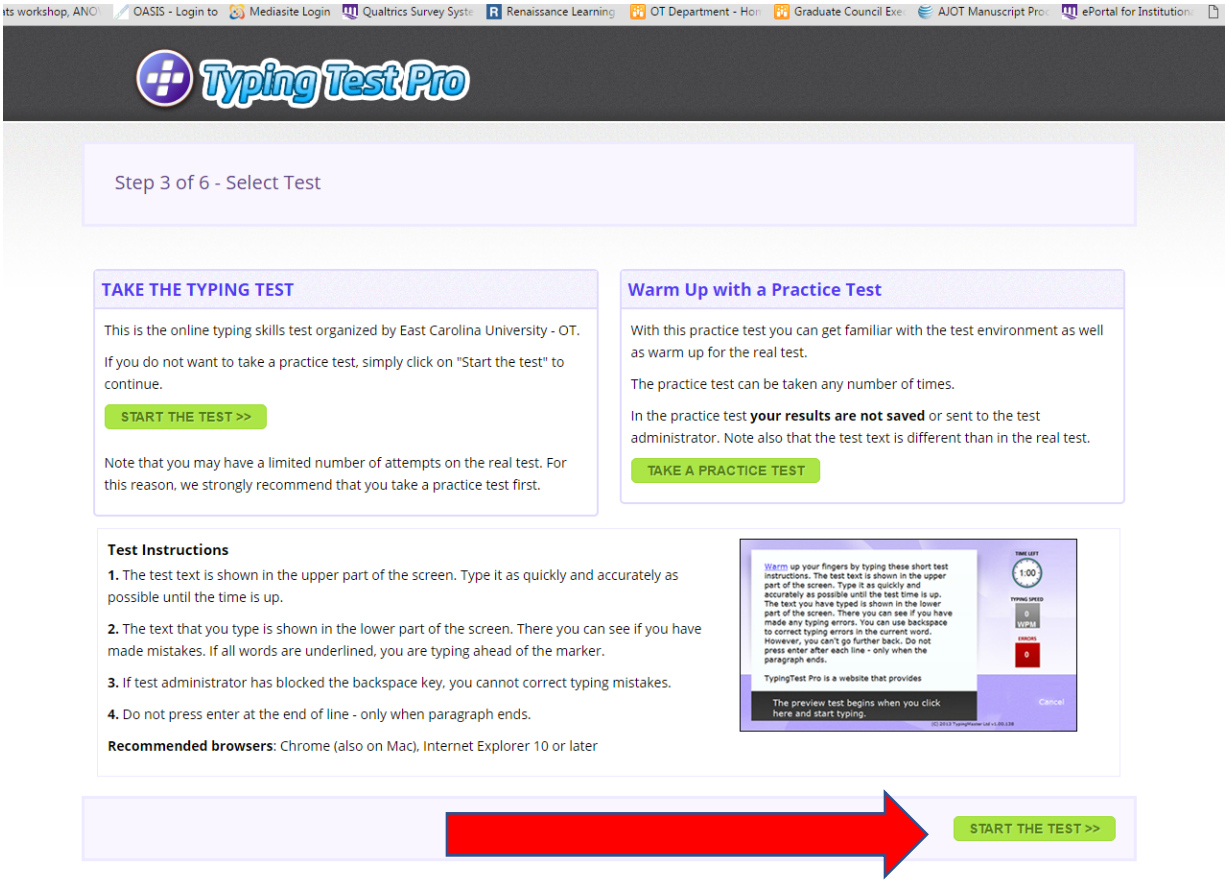
f. Read each of the 3 questions and ask the child to put an X in ONE box that applies to how often they do those things. You may elaborate or give examples of time-frames if necessary, especially for younger children.

g. As the child if s/he has ever been taught keyboarding or typing. Circle YES for yes and NO for no.

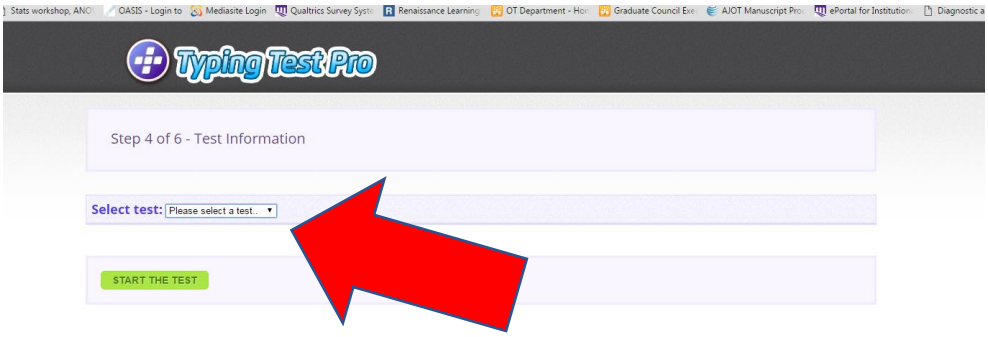
4. Place these forms on the computer beside the child so that the rating can be completed by the researcher.
5. Have the students set the pencils aside (or collect if they become distracting).
6. Ask the students now to pay attention to the computer.
7. For email address, have the child (or you can) type a fabricated email as indicated below
    a. Madison Avenue Elementary: LUNCH NUMBER@madisonl.com (103@madisonl.com)
    b. Madison Avenue Upper Elementary: LUNCH NUMBER@madisonu.com (103@madisonu.com)
    c. Mannsdale Elementary: LUNCH NUMBER@manl.com (103@manl.com)
    d. Mannsdale Upper Elementary: LUNCH NUMBER@manu.com (103@manu.com)
8. You will need to type this email address in both boxes. (Once you type it you can copy/paste into the lower box if you'd like).



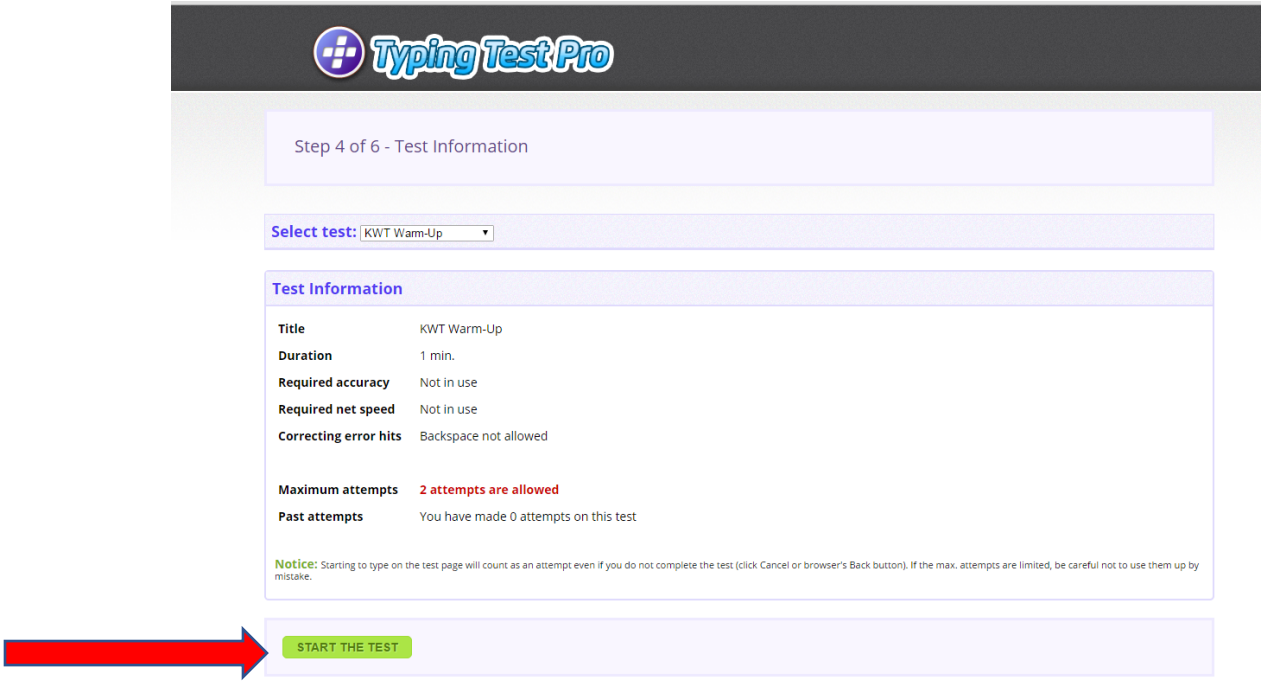
9. On the next screen, for <u>FIRST NAME</u> have the child type the abbreviation of the school:
    a. Madison Avenue Elementary: MAE
    b. Madison Avenue Upper Elementary: MAUE
    c. Mannsdale Elementary: ME
    d. Mannsdale Upper Elementary: MUE
10. For <u>LAST NAME</u>, have the child type their LUNCH NUMBER
11. Make sure everyone is on the next screen. Have the child select the green box that says START THE TEST at the bottom of the screen.



12. Help the child click on the drop arrow and select KWT WARM-UP.



13. The screen will change to the picture below. Then click START THE TEST. I have allowed two attempts in case something gests messed up.

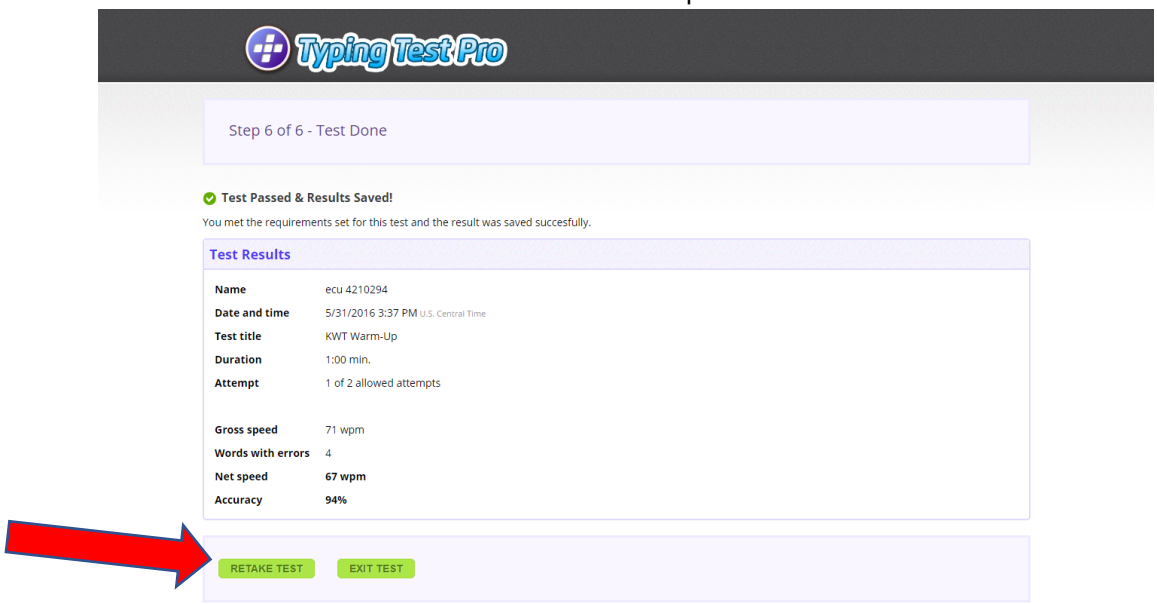


14. The typing test will appear but it will NOT start until the child clicks “Click or tap here and start typing.”

15. When all of the students are at this point, tell them the following directions.

    “Please wait for directions. This typing sample is a practice. I want you to type as many of the words as you can as they turn blue. You cannot fix mistakes, just keep going. When the practice is over, you will not be able to type anymore and you can stop. Any questions? Click where it says ‘Click or tap here and start typing’ in order to begin”

16. You will see a screen like this after the test is complete. Click on RETAKE TEST.



17. You will see the screen in number 13. Use the dropdown menu to select “Keyboarding Sample 1”

18. Then follow steps 14-16 and then after selecting RETAKE TEST, return to item number 13 and select from the dropdown menu “Keyboarding Sample 2”

19. During Keyboarding Sample 1 or Keyboarding Sample 2, the observing researcher needs to make note of the method used for keyboarding for each child at the bottom of the “Post-Test Data Collection Form”

    (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, 2010).

20. Click on EXIT TEST once all 3 keyboarding passages have been typed.

21. Please make sure all keyboarding observations have been completed. Thank them for their time.