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The Impact of Technology Access, Attitudes, and Use on Student Typing and Writing Performance

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To the Graduate Council:

I am submitting herewith a dissertation written by Carly Ann Chwat entitled "The Impact of Technology Access, Attitudes, and Use on Student Typing and Writing Performance." I have examined the final electronic copy of this dissertation for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy, with a major in School Psychology.

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The Impact of Technology Access, Attitudes, and Use on Student Typing and Writing Performance

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Abstract

To gain more information about student writing and typing skills, typed and handwritten responses to narrative story prompts were compared. Across two passages, total words written and story readability were examined. In addition, the potential impact of previous experience with, and attitudes toward, technology that may affect student performance on computer-based assessments, were evaluated. This examination was completed by pilot testing a survey created for this study. Information about student use of, and attitudes toward, technology was gathered through this survey, which examined usage of technology and student endorsement of certain statements about their skills with technology.

Analysis of total words handwritten and typed suggests that students handwrote significantly more words than they typed. In addition, readability scores were significantly higher for handwritten responses. Factor analysis of the survey suggested 3 unique factors; however, some subscale correlations were considered to be questionable, and any results using this survey data should be interpreted cautiously. Overall, correlations do not suggest any strong relationship between typing performance, technology usage, or attitudes toward technology. Theoretical and applied implications of the findings, study limitations, and directions for future research are discussed.

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Chapter I

Review of the Literature

Writing is a foundational academic skill that leads to both functional and creative communication, and is important not only for students at the elementary school level, but also for individuals in higher education and vocational settings (Graham, 2008). However, writing is researched less frequently than math and reading; The National Commission on Writing (2003) has referred to writing as the "neglected R."

Previous research suggests that nationally, less than one third of 8th and 12th grade students write proficiently, a number that has been relatively steady for about the last decade (National Center for Education Statistics, 2003; National Center for Education Statistics, 2011). In addition, previous research also suggests that poor writing skills tend to compound across grade levels, meaning that struggling early writers will continue to struggle (Graham, McKeown, Kiuhara & Harris, 2012).

Recent Common Core State Standards indicate that high school graduates should be capable of writing coherently in both academic and vocational settings. However, previous research suggests that of those students who enter the workplace following graduation, 38% do not have sufficient skills to produce quality written work (Costa, Hooper, McBee, Anderson & Yerby, 2012; Achieve, Inc., 2005). This inability to write clearly and effectively carries over into higher education, with a survey of university faculty reporting that nearly half of high school graduates cannot meet the requirements of writing at the university level (Duijnhouwer, Prins & Stokking, 2012).

A new trend in education, along with the implementation of Common Core State Standards, is the use of computer-based assessments. Computer assessments are being used for all academic areas, including writing (Fink, 2016). A major concern with the implementation of these assessments is that they are administered early and as young as 3rd grade, and that students are expected to have the technology skills to complete the assessments (Fink, 2016). It is not clear that students have the typing skills necessary to demonstrate their skill development in any academic areas, particularly in writing (National Center for Educational Statistics, 2003; National Center for Educational Statistics, 2012; White, Kim, Chen, and Liu, 2015)..

To demonstrate writing skills on these computer assessments, student typing skills will become more important as many state and national standardized assessments move to a computer-based format, assessing students' writing skills but requiring them to type (PARCC, 2015). Current school-aged children are often categorized as "digital natives," having grown up with technology and easily developing the skills needed to use it (Prensky 2001). Despite this, the question remains as to whether they actually have developed typing skills and if these computer-based assessments are a fair measure of the academic skills they are attempting to assess.

Data from previous research has suggested that fourth-graders write less while using a computer when compared to fourth-graders who completed a similar assessment on paper, and also suggested that limited keyboarding and word processing skills may be associated with limited prior exposure to writing using a computer. Furthermore, previous research has not specifically compared attitudes toward technology and use of technology to typing performance. Review of previous research provides some information regarding student attitudes toward

technology, but the literature does not reflect a focus on elementary aged students (Kim, & Glassman, 2013; Wang, Jackson, Wang, & Gaskin, 2015; Wang, Hsu, Campbell, Coster, & Longhurst, 2014). The results of the past research and of this proposed study may have implications for computer-based assessment, and for the integration of technology into educational settings.

Technology Standards and the Common Core

Increased use of technology in schools has been a goal of the U.S. Department of Education for well over a decade. Many school-aged children have grown up with increasing access to many forms of technology. In the Enhancing Education through Technology Act of 2001, the U.S. Department of Education set goals of improving academic achievement through the use of technology in classrooms, having all 8th graders being technology-literate, and integrating technology training and resources with teacher training to develop best practices.

Furthermore, newly implemented Common Core State Standards reflect technology-related writing standards students are expected to meet, including the College and Career Readiness Anchor Standards for Writing. These standards state that students should be able to "use technology, including the Internet, to produce and publish writing and to interact and collaborate with others" (Common Core State Standards Initiative, 2016). However, a Center on Education Policy (CEP) survey of deputy state superintendents of education found many states anticipated major technology challenges in implementing computer-based assessments of the Common Core standards. These professionals cited concerns such as challenges related to having adequate computers and Internet access, and having the personnel to address assessment-related technology problems (Kober & Rentner, 2012).

With the implementation of Common Core curriculum standards in states across the country, many states are turning to assessments designed by the Partnership for Assessment of Readiness for College and Careers (PARCC) and the Smarter Balanced Assessment Consortium (SBAC). Starting in 2010, many states moved to replace state curriculum-based assessments with digital assessments designed to measure progress toward Common Core standards. These assessments are designed to be delivered via computer or tablet, with the expectation that students will become familiar enough with these forms of technology to complete the assessment (Scholastic, 2016). It is important not only that students meet new Common Core standards, but also that student performance is accurately assessed. It is unfair for students when their lack of technology skill impacts performance on a standardized assessment, and computer-assessments may not be a valid reflection of a student's academic knowledge.

Supporters of Common Core State Standards and computer-based assessment argue that electronically delivered assessments are engaging for students, and that computer-adaptive testing may produce fewer floor and ceiling effects, resulting in more accurate scores (Porter, McMaken, Hwang, & Yang, 2011). However, as of May 2016, just 6 states planned to implement the PARCC-designed assessment in the 2016-17 academic year, with 14 states planning to implement the SBAC-designed assessment. A total of 38 states have left one or both testing consortia (Education Next, 2016). In addition to concerns about the role of high-stakes testing in education, many schools were also concerned about the resources needed to implement a technology-based test. While current school-aged children have grown up with technology, computer-based standardized assessments assume a certain level of technological ability on the part of students which they may or may not actually possess. In addition, previous research has

suggested that scores on these tests may be confounded by students' skills with technology and their level of comfort with the computer-based format (National Center for Educational Statistics, 2012; White, Kim, Chen, & Liu, 2015).

Technology and Education

Digital Nativism

Children in the current school-age generation are considered to be "digital natives," a term first used by Prensky (2001) to describe generations born after 1980. This term refers to those who have grown up with, and are immersed in, technology. However, the question remains-exactly what technology skills do these students actually have? Research has resulted in an uncertain understanding of how previous experiences impact the learning of digital natives, and whether they are different in fundamental ways from "digital immigrants" who did not grow up with access to the same technology. Consequently, determining the actual experiences of these digital natives is a reasonable and desirable research goal (Prenksy 2001, 2011; Tapscott 1998; Wang, Hsu, Campbell, Coster, & Longhurst, 2014).

Wang, Hsu, Campbell, Coster, and Longhurst (2014) examined the experiences that middle school students and their teachers have with technology using a mixed-methods survey approach. They also conducted focus group interviews to investigate any barriers that prevented them from using technology in school. This population of students indicated they use technology at home for communication and information, while their classroom experiences focused more on word processing and presentations. Overall, teachers reported that students had limited skills with technology such as cloud computing tools, but acknowledged that students could learn to use these tools. However, teachers identified the following barriers to using technology in the

classroom: lack of sufficient technology skills and integration strategies, a fear of looking unskilled in front of peers, and an inability to solve student problems with technology.

Currently, there is limited research on this third generation of school-aged students and their use of technology. Furthermore, each generation of digital natives has grown up with access to different technologies, making continual research necessary. Although in their review of previous research Wang et al. (2014) focused on the experiences of second-generation digital natives, it is still relevant to the experiences of school-aged children; they found that most students used technology outside of school for social and communicative purposes, with more limited use of technology in school compared to outside of school. However, since previous research on this new generation of digital natives is limited, it may be difficult to make assumptions about the technology skills of this population.

Computer-Based Assessment of Writing

Given the limited research on the technology skills of current school-aged children, and the implementation of computer-based assessments, it is important to examine the role that technology skills may play in student performance on computer-based assessments. Currently, research has not fully examined the difference in the quality of student performance on handwritten and typed tasks. Researchers in Scotland and Australia interviewed university students to better understand their perceptions of their typing skills (Mogey & Fluck, 2015). They found the majority of students were confident in their typing skills and reported they could type at least as fast, or faster, than they could handwrite. Students also reported they were more likely to edit a computer-produced response, that their computer responses to essay examination questions produced better arguments and structure, and their typing was a better use of their time

than handwriting. This study relied on responses to survey items, but lacked data on student achievement to examine the accuracy of their perceptions about their typing skills, story composition, and editing quality. Recently, in the United States, similar questions were examined through a computer-based assessment of writing administered by the National Center for Educational Statistics (NCES).

National Assessment of Educational Progress, 2010

In 2010, NCES examined the performance of 24,100 8th graders and 28,100 12th graders on a writing assessment, which was composed on a computer. This assessment provided information not only about student writing skills measured by computer assessment, but also about the potential impact of previous use of technology on student typing performance. Overall, the NAEP assessment found that 24% of students in both grades eight and twelve were "Proficient" in writing, a rank that represents "solid academic performance" and "clearly demonstrated the ability to accomplish the communicative purpose of their writing." In addition, 54% of eighth graders and 52% of twelfth-graders were considered to be at a "Basic" writing level, showing a "partial mastery" of fundamental writing skills (National Center for Educational Statistics, 2012).

Data collected from this assessment also provided information about students' use of certain tools on the laptops provided for the assessment. At the onset of the assessment, students were shown a tutorial to help them become familiar with the software used for the assessment, which was designed to be similar to common word-processing programs. Use of editing tools featured within the program were found to be correlated with performance. For example, on average, students who used the thesaurus tool more frequently scored higher than their peers who

used it less often. Some tools were used more frequently than others; 74% of twelfth- graders utilized the spell-check tool at least one time, but 80% of twelfth-graders did not use the cut, copy, and paste tool (National Center for Educational Statistics, 2012). Overall, these data suggest that students who used editing tools, and who may have been more familiar with using similar word-processing programs may have performed better on the assessment.

Students and teachers also were surveyed about their use of technology in the classroom. When asked about their computer use, 56% of twelfth graders reported always or almost always using a computer to edit their writing, while 4% reported never or hardly ever using one. Additionally, twelfth graders who reported using a computer more frequently to edit their writing had higher average writing scores than students who reported less frequent computer use. The teachers of participating eighth grade students were also surveyed; students whose teachers incorporated more frequently computer use to write and revise writing scored higher than those students whose utilized a computer less often for writing in the classroom. The results of these patterns in performance may suggest a potential benefit of computer-based assessment when students have previous access to and experience with technology, and specifically when these experiences included using a computer to edit written assignments.

NCES also collected data on demographic variables that correlate with differences in performance. According to the data from this assessment, a larger percentage of students who were eligible for free/reduced lunch programs at their schools performed at the Basic level, compared with students who were not eligible. Furthermore, students in suburban schools performed better in both grade levels than students in urban or rural schools. Additionally, students who reported higher levels of parental education had higher average writing scores

compared to peers (National Center for Educational Statistics, 2012). These patterns in performance may suggest a beneficial impact of access to greater resources, including access to technology, from parental education and attendance at schools in areas with a higher socio-economic status.

National Assessment of Educational Progress, 2012

In 2012, NCES administered a follow-up computer-based pilot writing assessment to approximately 10,400 fourth-grade students. This study compared student performance to a 2010 paper-based assessment and found that while different groups of fourth- graders had similar overall average scores on the 2010 written assessment and the 2012 typed assessment, high-performing fourth-graders scored higher on average on the computer compared to paper. However, the results of this assessment suggest low- performing students did not benefit from using a computer, and a higher percentage of low-performing students were less likely to use spell check or to edit their work, suggesting that the 2012 computer assessment may not have accurately assessed their writing skills (White, Kim, Chen, & Liu, 2015). Furthermore, a serious flaw in this study that limited confidence in the conclusions is that the comparisons in typed and handwritten performance were not made between the same group of students or even within the same year, making it difficult to make accurate conclusions about differences in performance.

Students with access to a computer at home were also more likely to prefer writing on the computer to writing on paper. Furthermore, students with access to the Internet at home were more likely write longer responses, and to use spell check and the thesaurus tool. 94 percent of

high-performing students had home Internet access, compared to 52 percent of low-performing students (White, Kim, Chen, & Liu, 2015).

The results of these NAEP assessments suggest that there may be a relationship between access to technology and performance on computer-based assessments. High-performing students were more likely to have access to the internet than low performing students, and students with internet access were more likely to write more. Furthermore, the results of this study seem to suggest a difference in student performance on typed and handwritten tasks, suggesting that results of computer-based assessments may be influenced by variables other than simply student writing ability, such as previous experience using computers and classroom activities related to typing and editing. However, the NAEP studies did not directly compare student performance on a written assessment versus a typed assessment administered within a short timeframe nor did they compare the same student's performance across testing modalities. The results of this study have implications for the teaching of technology-related skills as NAEP assessments seem to suggest that familiarity with computers is important for performance on assessments. It is important to consider the other variables aside from academic ability that may be influencing performance on computer-based assessments as they become a new method of assessment under the Common Core State Standards.

Technology, Writing, and Self-Efficacy

Another factor to consider when examining the usage of and attitudes toward technology in school-aged children is their self-efficacy with technology. According to Bandura, self-efficacy is a person's belief they can be successful in a certain behavior, and more specifically, that they can follow through on a set of problem solving behaviors that allow them to work

within a situation (Bandura, 1982). Understanding an individual's self-efficacy related to technology may help to explain more about why they use certain types of technology. There are elements of Bandura's social cognitive theory that can be applied to an understanding of self-efficacy for writing, and for any other academic experience. Furthermore, social cognitive theory also highlights the importance of an individual's developmental level as a factor in learning, making it a useful framework for attempting to focus on the unique experiences of different generations of students. Self-efficacy can be described in terms of Bandura's concept of triadic reciprocality, where there is an interaction among the environmental, behaviors, and characters of an individual, such as their cognitions (Schunk, 2012).

From the social cognitive perspective, there is a connection between the technology in a person's environment, their usage behaviors, and their attitudes and beliefs about their usage of technology. Individuals choose to engage in behaviors in which they will be successful. They are reinforced for certain behaviors, which then increases self-efficacy, which then increases confidence the behavior will be successful and rewarding again. Over time, an individual expects a certain outcome, making them more motivated to engage in a behavior. Behaviors related to technology may be unique due to the many behaviors involved in the use of technology which are complex, and means that reinforcement is often further away or requires the completion of more steps. It is difficult to define what is simple or complex as this varies among individuals (Kim & Glassman, 2013). Kim and Glassman (2013) suggest self-efficacy is an important construct in the context of technology usage, which is relevant to the variables examined in this proposed study. One purpose of this current study is to address typing and technology attitudes

by assessing student endorsement of certain skills presumed to be related their level of self-efficacy with typing and technology usage.

Furthermore, previous research suggests writing self-efficacy is important when examining student writing outcomes in academic settings. Research suggests that student confidence in writing is related not only to overall writing competency, but also to writing self-concept, writing apprehension, perceived value of writing, and also overall achievement goals (Pajares, Hartley, & Valiante, 2001). A review of the literature by Pajares, (2003) suggests that students' confidence in their writing capabilities can influence their motivation to write, as well as impact outcomes such as grade goals and expected outcomes of students. Previous research also supports a multi-factor model of writing self-efficacy, suggesting that higher levels of efficacy related to writing ideation, conventions, and self-regulation are positively correlated with self-reports of higher writing performance (Bruning, Dempsey, Kauffman, McKim, & Zumbrunn, 2013).

Summary

Writing is a foundational academic skill for students, but it is an area with a much more limited research base than other skills. National assessments of writing suggest about 70% of American students' writing can be described as "not proficient" (National Center for Education Statistics, 2012). Common Core State Standards describe writing level and technology proficiency (Common Core Standards Initiative, 2016). In the wake of Common Core State Standards implementation, many schools are moving toward computer assessment of student academic achievement. However, researchers have not examined some fundamental questions: (a) can students type as well or better than they write; (b) do other factors influence student

writing and typing performance; and (c) what relationships among technology usage skills, typing, and writing impact student achievement on computer-based assessments.

Furthermore, previous research into technology usage has not specifically focused on elementary school-aged children. The changing nature of technology makes it necessary to continually study the use of and attitudes toward technology. Review of previous research informs several components of this proposed study, such as technology self-efficacy, and writing and typing performance; however, the relations among these components are not clear. The purpose of this study is to expand on previous research examining student writing and typing performance, and also to evaluate performance as it relates to student usage of and attitudes toward technology.

Purpose of Proposed Study

The main purpose of this study was to add to the literature examining student performance on a response to a writing prompt. Specifically, this study examined students' handwritten and typed responses to determine if there are any significant differences between the two conditions. Previous research has suggested similarities between typing and handwriting from a production perspective, but also has suggested differences in performances on assessments (Pinet, Ziegler, & Alario, 2016; Purcell, Napoliello, & Eden, 2011; White, Kim, Chen, and Liu, 2015).

A second aim of this study was to create a survey that would measure students' use of technology and attitudes toward technology, typing, and writing. This survey could provide information about the types of technology students have experience using, which could provide information for teachers about possible improvements to their curricula (particularly when

preparation for computer-based assessments). Information about technology usage and a student's comfort with technology also could be helpful in planning interventions. In addition, there are applications for researchers who want more information about participants when conducting research related to technology, such as previous experience using certain technologies. As previous research suggests, a survey may provide researchers with information about participants' skills, background, and motivations to use technology (Kim & Glassman, 2013; Wang, Jackson, Wang & Gaskin, 2015). One goal of this survey is to measure the different types of technology devices students use at school and at home, and how often they use them.

A final goal of this study is to study is the attitudes of students toward technology, and to relate this to student typing and writing performance. There is limited research that addresses this goal, especially with regards to younger students. Davies (2011) provides some guidelines for three different levels of technology literacy that students progress through as they develop skills related to technology. They begin by becoming aware of the technology available and its uses. At the more basic praxis (or practice) level, they develop basic skills and become familiar with the functions of technology. At the more advanced phronesis level, a term which comes from a Greek word indicating a type of intelligence sometimes translated as practical knowledge, users become adept at using technology and become comfortable learning new applications.

Research Questions and Hypotheses

Research Question 1

Do students' performances on typed and handwritten writing tasks differ? Previous research has not directly investigated this question (Pinet, Ziegler, & Alario, 2016; Purcell, Napoliello, & Eden, 2011; White, Kim, Chen, and Liu, 2015). This study will examine student

performance on two writing tasks. Students will type one response and handwrite the other. Written products will be examined using a readability scale and total words written. Based on previous research, it is hypothesized that students will produce more words during the typed condition, but that there will be no significant difference in student writing quality (i.e., readability scale) between the typed and handwritten conditions.

Research Question 2

How does technology usage and attitudes toward technology relate to typing performance (i.e., typing speed and accuracy)? This question will be examined by measuring the relationship between use of technology and typing production (total words typed) and accuracy (readability scale). It is hypothesized that students who report greater usage of technology, along with more favorable attitudes about the importance of and their skills with technology, will perform better on the typing assessment than students who do not endorse these areas. This hypothesis is supported by previous research on computer-based assessment which indicated that students with access to a computer at home are more likely to prefer writing on the computer to writing on paper and that students with access to the Internet at home are more likely to type longer responses, and to use editing tools (Mogey & Fluck, 2015; National Center for Educational Statistics, 2012; White, Kim, Chen, and Liu, 2015).

Chapter II

Method

Participants and Setting

Data for this study were collected at a public elementary school in a rural school district in the Southeastern region of the United States. The district serves approximately 7,000 students, approximately 91% of whom are white. In the district, 12% of students have a disability, with 3.4% of students in the district considered to have limited English proficiency. About 70% of the students are considered to be economically disadvantaged (Tennessee Department of Education, 2012). Complete study data were available from 96 students. Data obtained from 21 students was omitted due to lack of parental consent, lack of student assent, or missing data. A majority of students (68%) reported that they had internet access at home, while 25% of students reported that they did not have internet access at home. A small percentage of students (7%) reported that they were not sure if they had internet access at home. All of these data were self-reported.

The Technology Usage and Attitudes Survey (TUAS) and writing prompts were administered during the early spring in 2017. All students were invited to participate, but data were analyzed only for students who had given assent and had parental consent. There were no other exclusionary or inclusionary criteria related to student academic performance. Complete data were available for 96 students. There were 48 male and 48 female participants. Complete data were available for 27 third grade students, 34 fourth grade students, and 35 fifth grade students. The TUAS was group administered by researchers during small group intervention time for each grade. Student writing prompts were group administered by researchers. Typed

responses to the writing prompt were typed on laptops, which were stored on a laptop cart within each classroom.

Materials

First, University of Tennessee Institutional Review Board-approved consent materials were sent home to parents of students in the third, fourth, and fifth grade at the elementary school. The Parent Consent Form and Information Letter is included in Appendix A. Prior to administration of the survey, the students were presented with the Youth Assent Form (Appendix B), informed of the research, and asked to sign. Students then completed the Technology Usage and Attitudes Survey (TUAS), which is included in Appendix C. In the written response condition, each student was presented with individual lined paper to write responses to story starters. The story starter for the written response condition was one page with the prompt typed across the first line. An example of this page is included in Appendix D. In the typed response condition, students responded in a word document that had the story starter typed on the top of the page. Students completed their responses in Word Pad, a Microsoft word processing program that does not feature spell check or grammar check.

Prompts selected by researchers for inclusion were randomly assigned to the typed and handwritten conditions. Prompts were narrative as previous research suggests this is the most appropriate writing task for elementary-age students (McMaster, Du & Petursdottir, 2009). Students completed prompts asking about "the best thing about school" and "the best thing about summer" to have as equivalent of prompts as possible.

To ensure administration of all conditions with integrity, scripts were developed for researchers to follow. A survey administration script is included in Appendix E. A writing

prompt condition script is included in Appendix F, and a typing assessment administration script is included in Appendix G. Each script is linked to a checklist for procedural integrity. These checklists are included in Appendices H, I and J.

Dependent measures

Student writing performance was evaluated using writing probes chosen to be as equivalent as possible. Student performance on both the handwritten and typed tasks were scored for a readability quotient, and for total words typed or handwritten.

Readability. Students' typed and handwritten responses were examined for readability to compare the complexity of writing performance on handwritten and typed responses using the Flesch reading-ease test. This test is commonly used to examine the complexity of writing and examines total syllables, words, and sentences written to create a measure of how difficult a passage may be to read. The readability ease score was calculated by considering the sentence length (the number of words divided by the number of sentences) and the average number of syllables per word (the number of syllables divided by the number of words). Reading ease scores range from 0 to 100. The higher the number, the easer the text is considered to be to read (My Byline Media, 2017). This test is readily available within Microsoft Word and was run on the typed responses and on handwritten responses (Kincaid, Fishburne, Rogers, & Chissom, 1975). Handwritten responses were typed into a word document by the researchers to obtain readability scores.

Total Words Written. Total Words Written (TWW) was calculated by counting the number of words written or typed by the participant for each prompt, without considering spelling or grammatical errors. TWW was calculated for both the typed and handwritten

responses. TWW is considered to be a reliable and valid measure, especially at the elementary school level (Gansle et al., 2006).

Technology Usage. For the purpose of this study, students were asked how many days per week they used different types of technology at home and at school. Technology usage was calculated for each student by averaging their total days of use of different types of technology. This score was calculated for home and for school, resulting in two average technology usage scores.

Attitudes. Attitudes toward technology were measured using the TUAS, a survey designed for this project. Examination of sample survey items resulted in a survey with three different subscales: Usefulness, Confidence, and Preference. These scales include items that examine a student's perception of the utility of technology, their confidence in using technology, and their preferences for typing or handwriting.

Procedures

Approval for the study was obtained through IRB at the University of Tennessee:, a from the principal of the elementary school; and from the director of Federal Programs, Elementary Education and Accountability, who approves research conducted in the school district. Care was taken not to interrupt high-value activities and to limit the time for the survey and writing assessments. Parent Consent forms were given to all students in the third, fourth and fifth grades asking permission for their child's participation in the study.

Phase 1: Survey Development and Administration

A research team focused on writing research developed a series of survey items for the TUAS. Items were examined to make sure that the wording would be appropriate for this age

group and to ensure that the survey items were relevant to the research questions. The structure of the survey was developed with consultation from the University of Tennessee's Office of Information Technology (evaluation of the TUAS is described in more detail in the Results section).

Students were given the assent form and a paper copy of the TUAS. Two researchers were present in each classroom. Researchers explained the study and the assent form and asked students to indicate if their data could be used in our research project, and then sign. Researchers read the instructions for the survey and then read all survey items to ensure that reading comprehension did not impact student responses on the survey. Researchers then collected the survey and the assent forms. One of the researchers also recorded information on an integrity checklist developed from the administration scripts to ensure procedural accuracy.

Phase 2: Experimental Conditions

Two experimental conditions were examined and all students were exposed to both conditions. Using similar procedures, students were asked to write a story and to type a story. Students were randomly assigned to be in the "typed first" or "handwritten first" condition and were randomly assigned a story prompt. First, the school roster for grades 3, 4, and 5 was organized alphabetically by last name. Then, students were randomly assigned to either the type first condition or the handwritten first condition based on roster position (e.g., even and odd). Next, students that were randomly assigned to the typed first condition were listed alphabetically by first name and randomly assigned a prompt based on roster position. The same occurred with the handwritten first group. Three classrooms of students were administered both conditions after students were placed into assigned groups based on both random assignments.

Written Condition. During the handwritten response condition, all students were provided with a paper copy of the story starter. Researchers read the instructions aloud to the students. Students were instructed that they had 1 minute to plan their story. After 1 minute, they were prompted to start writing. After 3 minutes, students were instructed to put their pencils down and stop writing. Researchers then collected the paper story starters.

Typed Condition. The instructions for the typed response condition were similar to the written response condition. During this condition, students worked on laptops that had a typed version of the story starter open. Students completed the typed prompt in Microsoft Word Pad, which had spelling and grammar check turned off. Students were prompted to start writing after 1 minute of planning time. At 3 minutes, they were instructed to take their hands off the keyboard and stop typing. They were then asked to save their document using their last name. Next, students were instructed to access the internet and to log into their email. They were guided through the process of creating a blank email, and attaching their file. They were instructed to send the email to a staff member within the school network, who forwarded the email to the researchers.

Confidentiality

Student names were removed from all handwritten documents and replaced with a code composed of a random assortment of letters. Student names also were removed from their surveys and replaced with their codes. Student typed files were saved using the assigned code, and all documents were reviewed to ensure that no student names remained on any products. Student names and codes were stored separately from any data, so that researchers did not know the name of the students whose responses they were scoring.

Procedural Integrity

All survey and writing prompt administrations were monitored by at least two researchers. Procedural integrity checklists were completed during all data collection conditions to ensure that all directions were administered similarly for all participants. An integrity checklist, derived from the relevant script, was used to assess how closely the graduate student researcher followed the script. The checklists for each phase are included in Appendices I, J, and K. Percent agreement with the established script procedures was calculated by taking the total number of steps completed, dividing by the sum total number of applicable steps to the script, and multiplying by 100.

For data collection, there were three pairs of researchers present to collect data simultaneously in three settings. Data collection took place over two days. During all days of of data collection, all three pairs of researchers reported 100% integrity with the checklist, indicating that they followed all of the steps of the integrity checklists. Because each classroom was assigned two graduate student administrators, one completed the procedural while the other gave instructions to students.

Interrater Reliability

To ensure correct calculation of total words written, total words typed, and readability scores for both typed and handwritten student responses, interrater reliability was calculated for all student products. Because all responses were typed into a word processing document, IRR was verified by computer and the primary researcher. In addition, when two scorers disagreed, retraining occurred and the responses were rescored. Interrater reliability (IRR) was calculated

by dividing the smaller number by the larger number and then multiplying by 100 to create a percentage.

Total words written was counted independently by two researchers, including the primary researcher and a graduate student research assistant. Out of 96 handwritten prompts, 8 were reexamined due to inconsistent scores. Therefore, initial IRR for total words handwritten was 93.8%. After rescoring, IRR was 100% for total words written. In addition, handwritten responses were typed into a word processing program (to calculate readability scores) by the primary researcher, and were again monitored for any input errors. Because the total words handwritten had already been calculated, any errors in total words typed were noticeable to researchers using the word count feature in Word processing. Total words typed was calculated using the word count feature in Word, which can be accessed using the spelling and grammar tool. The primary research counted the total words a student typed and then verified that count in Word. The initial IRR for total words typed was 96.8%. All initial scoring errors were corrected.

Readability scores were calculated using the feature in Word by both the main researcher and a graduate assistant to ensure that scores were entered correctly. The initial IRR for handwritten readability was 95.8% and the initial IRR for typed readability was 85.4%. In some cases, a graduate assistant was including the story starter in calculations. Retraining occurred. All readability scores were re-calculated by the primary researcher and compared against the computer derived scores, to ensure that interrater reliability was 100%.

Chapter III

Results

In the results section, student performance on different writing tasks, as well as the initial validation process for the TUAS, is examined. Comparisons between the mean total words typed and handwritten, as well as readability scores for student responses are discussed. Furthermore, average days of student technology usage at home and at school, as well as student responses on the TUAS, as it relates to typing performance, is examined.

Research Question 1

Do students' performances on typed and handwritten writing tasks differ? This study attempted to expand on limited previous research by examining student performance on two writing tasks, one handwritten and one typed. To answer this question, the mean number of words typed and the mean number of words handwritten were compared. In addition, the Flesch Ease reading test scores for typed and handwritten responses were compared between groups to examine readability.

For total words handwritten, the mean words written was 38.41, with a range from 3 to 88. The standard deviation was 15.944. Data for total words handwritten was fairly normally distributed. The mean Flesch Ease reading scores for the handwritten task was 77.05, with a range from 0 to 100. The standard deviation was 29.23. For total words typed, the mean words typed was 32.39 with a standard deviation of 23.28. The minimum total words typed was 0, while the maximum was 139. Data for total words typed was positively skewed. The mean Flesch Ease reading scores for the typed task was 56.22, and the standard deviation was 41.77. The range from these scores was from 0 to 100.

Table 1 displays the means and standard deviations across dependent variables, including total words typed, total words handwritten, and the Flesch Ease reading test scores for both typed and handwritten responses.

Table 1

Dependent Variable Mean, Range, and Standard Deviation

	Mean	Standard Deviation	Range
Total Words Handwritten	38.41	15.94	3-38
Total Words Handwritten Readability	77.05	29.23	0-100
Total Words Typed	32.29	23.38	0-139
Total Words Typed Readability	56.22	41.77	0-100

Comparisons of Means

A Wilcoxon Signed Ranks test examined the means for total words written and handwritten to compare them. The test statistic for the Wilcoxon Signed Rank examines positive and negative ranks; if the null hypothesis is true, there would be a similar number of lower and higher ranks that are both positive and negative, meaning that there would not be a significant difference in the data. This test was run as the means for total words were not normally distributed. The Wilcoxon Signed Ranks test indicated that the total words handwritten (M = 38.41; SD = 15.94) was significantly higher than the total words typed (M=32.39; SD=23.28), z

(96) = -3.784), p = 0.00. Readability scores were also significantly higher for the handwritten (M = 77.05; SD = 29.23) responses than for the typed responses (M=56.22; SD=41.77), z (96) = -4.156, p=0.00). Table 2 shows the results of the Wilcoxon Signed Ranks test.

Table 2

Comparison of Total Word Means and Readability Means

		Mean Rank	Sum of Ranks	Z	Significance
Pair 1 Total Words Handwritten-Total Words Typed	Negative	50.17	3110.50	-3.784	0.000*
	Positive	38.92	1167.50		
Pair 2 Handwritten Readability-Typed Readability	Negative	49.93	2896.00	-4.156	0.000*
	Positive	32.14	932.00		

*significant at the 0.000 level (two-tailed)

Research Question 2

How does technology usage and attitudes toward technology relate to typing performance? This research question examined the relationship between use of technology and typing production (total words typed) and accuracy (readability scale). It was hypothesized that students who reported greater usage of technology, along with more favorable attitudes about the importance of and their skills with technology, would write more than students who did not endorse these areas**.**

Survey Development

Item Identification. A team of researchers developed survey items for the TUAS, focusing on wording that would be clear for the age group participating and relevant to the research questions. In addition, the structure of the survey was also developed with consultation from the University of Tennessee's Office of Information Technology. A copy of the final survey can be found in Appendix C.

Initial Analysis. First, an exploratory factor analysis was conducted to examine the underlying factor structure of the TUAS and to determine if any items on the scale fell into related subscales. Prior to performing the factor analysis, the Kaiser–Meyer–Olkin measure of sampling adequacy was examined and found to be 0.626, which is considered mediocre (Beavers et al., 2013). This result suggests that the proportion of variance among variables that might be common variance is limited and below acceptable levels. The Bartlett's test of sphericity was significant, X^2 (96) = 479.68, p = .000. Following previously established criteria, the following values were set to determine which items to retain in the survey (Kim & Mueller, 1978). Items with primary factor loadings .70 (including values that rounded to .7) and secondary factor loadings .30 (including values that rounded to .3) were included in the scale (Tabachnick & Fidell, 2013).

Furthermore, the variance in factors was examined and only factors with an eigenvalue of 1.00 or higher were included (Tabachnick & Fidell, 1996). All items not meeting the criteria were examined and removed. There were 7 eigenvalues greater than one and the examination of the Scree plot suggested a 4-factor solution (Beavers et al., 2013). However, a 3-factor solution

was selected to ensure that the items loaded in scales that related to each other. Overall, the three-factor solution accounted for 52.53 % of the variance.

Reliabilities were estimated using Cronbach's alpha. Of the 21 initial items, 12 items were retained. While a standard metric typically retains scales that have a reliability of 0.8, the reliability for the 12 items that were retained for the TUAS were slightly lower, ranging from 0.49-0.67 (DeVellis, 2012; George & Mallery, 2003). However, as this is a pilot testing of the survey, these scales were retained. Necessary items were reverse coded for analyses. Table 3 in Appendix K shows the statistics for each item, and Table 4 in Appendix L shows the Component Matrix for the survey.

Survey Scales

Based on the discussed analyses, the TUAS appears to have three factors. Table 5 in Appendix M displays the items and reliability for the three factors of the TUAS. These scales were identified as Usefulness, Preference, and Confidence. Overall, these scales accounted for 50% of the variance. The overall reliability for the total scale with 12 items was $\alpha = 0.65$.

Usefulness. The first factor, *Usefulness* ($\alpha = 0.699$), contains 5 items and accounts for 41.75 % of the variance. The *Usefulness* factor encompasses questions about students' views of technology and typing as being useful and important.

Confidence. The second factor, Confidence ($\alpha = 0.620$), includes 4 items and accounts for 24.43 % of the variance. The items in this subscale examine student beliefs in their abilities to use technology, as well as the need to ask for help.

Preference. The third subscale, Preference, has a reliability of 0.696, and accounts for 33.81 % of the variance. The Preference factor has 3 items. These items examine student preference for typing versus handwriting.

Table 6 shows the correlations between each of the subscales. Correlations below .30 are considered low. Correlations between .30 and .60 are considered moderate, and correlations above .60 are considered high (DeVellis, 2012; George & Mallery, 2003. The results of this correlation suggest that none of the subscales are highly correlated with each other, with scores ranging from -0.010 to 0.195. There is a negative correlation between Usefulness and Confidence.

Table 6 *TUAS Subscale Correlations*

	1	2	3
1. Usefulness	1		
2. Preference	.195	1	
3. Confidence	-.010	.141	1

Correlation between technology use, attitudes toward technology, and typing performance

To answer research question 2 and to examine how technology usage and attitudes toward technology relate to typing performance, several correlations were performed. Correlations were computed using SPSS 24.0 (IBM, 2016). Spearman's rho, a nonparametric

measure of statistical dependence between the rankings of two variables, was performed as the data for the typed responses were not normally distributed.

First, correlations between the students' usage of technology and their attitudes toward technology were examined. To synthesize student usage data, an average technology usage score was calculated for home and for school for each student. The relationship between student ratings on each subscale of the TUAS and total words typed also were examined. The resulting correlations are displayed in Table 7 in Appendix N.

There were no significant correlations between the average days of technology used at home and at school, and each subscale of the TUAS. The highest correlation occurred between average days of technology usage at home, and the score on the Preference subscale of the TUAS (0.26). However, this is considered to be a low correlation. A negative correlation was found between average school technology usage and TUAS Preference (-0.066). A negative correlation was also found between school average and Confidence (-0.086). Both of these are very weak correlations.

Second, the relationship between home and school technology usage averages with total words typed was examined. Results did not suggest any significant relationship between usage averages and total words typed, with correlations ranging from -0.101 to 0.194. There was a negative correlation between total words typed, and average days of technology usage at home.

Chapter IV

Discussion

Writing is an essential, but rarely researched, academic skill. National assessments suggest about 70% of American students are "not proficient" in writing (National Center for Education Statistics, 2012). This finding is particularly concerning as Common Core State Standards require students to be proficient writers. Furthermore, these standards also require that students be able to perform on computer assessments of academic achievement, which will require students not only to write a story but to do so while using a word processing program (Common Core Standards Initiative, 2016).

Many states in the country, including the state of Tennessee, are moving toward the use of computer-based tests instead of paper tests for their standardized state assessments. In the state of Tennessee, the results of student performance on these state assessments are used to evaluate the quality of classroom teachers. It is essential that these assessments are accurate and valid, and are measuring academic skill. Decisions about teacher effectiveness cannot accurately be determined from assessments that may be influenced by factors outside of their control. Previous research suggests that there are some differences between student performance on handwritten and computer-based assessments, and that there may be some demographic factors and variables that affect student performance (National Center for Education Statistics, 2003; National Center for Education Statistics, 2011).

A flaw of previous research by NCES (2010), which this project is attempting to correct, is that comparisons in typed and handwritten performance were not made between the same group of students or even in the same year. However, another NCES (2012) computer-based

pilot writing assessment found that low-performing students were less likely to use word processing editing tools, suggesting that they may not have benefitted from taking the assessment on the computer. In addition, there are some variables that affected student performance that could be related to previous experience with technology. Data suggested that students who used editing tools and students who reported using computers more often in class (who may have been more familiar with word-processing programs) performed better on the writing assessment (National Center for Education Statistics, 2011). Students in rural/urban schools and those eligible for free/reduced lunch performed at lower levels compared to peers, as did those with lower levels of parental education and those without access to internet.

These patterns may suggest the impact of access to greater resources on student performance. They also suggest the need for careful evaluation of computer-based assessments. If factors such as parental education account for variation in student scores on assessments, then it is inappropriate to use student scores to evaluate teachers. Furthermore, Tennessee's value-added teacher assessment system considers student growth across the year in addition to whether or not they meet proficiency standards. Therefore, it also is essential that any assessments must be accurate and valid so that they can potentially be compared to past assessments (Tennessee Department of Education, 2017). Students may not perform well on new versions of computer tests requiring them to use certain programs that they have not have extensive practice using.

While students who have grown up with technology are thought of as 'digital natives' who have skill using technology, previous research on this population indicates that technology usage skills may be limited (Prenksy 2001, 2011; Tapscott 1998; Wang, Hsu, Campbell, Coster, & Longhurst, 2014). Therefore, it cannot be assumed that students who fall into the category of

being digital natives actually have technology skills. These skills, including specific typing and keyboard skills, should be explicitly taught, especially if these skills are necessary for students to complete academic assessments. Furthermore, there is very limited research on the specific typing and word processing skills of this population.

The overall results of this study suggest that regardless of previous experience using different types of technology and regardless of their attitudes toward technology, elementary aged students cannot type. Overall, the results of the TUAS suggest that while students may report that they think they are good at typing or that they would rather type than handwrite, there is no relationship between their response to questions about typing and their actual typing performance. In fact, students in this study wrote longer and more complex responses when handwriting as opposed to typing.

This finding is extremely concerning, as in the state of Tennessee, students will be required to complete standardized state writing tests on the computer, starting as young as 3rd grade. The results of this study seem to extend the results of previous research examining computer-based writing assessments, and support the idea that there are factors that influence performance beyond pure academic skill. Therefore, these tests may not be accurate measures of student writing performance. Furthermore, student perception of their technology skills, and specifically typing skills, may not be accurate.

This study is the first of its kind that compares both typed and handwritten performance for the same population of students. Previous research did not compare performance for the same students at the same time. While previous research is limited, it was hypothesized that students would handwrite more words than they typed. Students in this study were presented with similar

tasks and asked to respond to narrative prompts, which are considered to be appropriate for the ages of the participants involved. Prompts and conditions were randomly assigned to students, even to students within the same class, to control for any impact of presentation order, class composition/assignment, or variables related to a certain teacher.

Research Question 1

The results of this study suggest that, when presented with similar tasks, students handwrite significantly more words than they type. This finding suggests that there is a significant difference in student performance on computer-based vs. paper and pencil tasks, and it cannot be assumed that computer-based assessments are comparable to paper-based assessments.

Furthermore, readability scores were calculated for both handwritten and typed student responses to compare the complexity of writing on these different tasks. The Flesch Reading Ease test provides a score that is calculated by examining average sentence length, and average number of syllables per word, as well as the total words written. The readability scores, which essentially rate how difficult a passage is to read, suggest that handwritten responses are significantly more complex when compared to typed responses on similar tasks. In summary, students not only write more words, but they also write longer words and longer sentences when they handwrite, as opposed to when they type. This result also has significant implications for computer-based assessments and may suggest that students can better express themselves when handwriting a story. There may be factors that influence performance while typing that might be limiting student performance.

For example, given the results of this study, it may be that students did not have necessary typing skills to quickly compose a story. In addition, students may have been required to use more cognitive load to focus on the actual mechanics of typing/word processing, resulting in less complex and shorter typed responses. Therefore, typed assessments may not be an accurate assessment of academic skill.

Research Question 2

The second aspect of the study was an attempt to create a survey to examine technology usage and attitudes toward technology in elementary-aged students, which has not previously been evaluated. The goal of this survey was to examine how technology usage and attitudes toward technology relate to typing performance. The hypothesis was that students with more experience using technology and strong beliefs in their ability to use technology would be better in typing a story. While there are limitations to the survey developed for this project (discussed in Limitations), the results do suggest some interesting areas for further research. However, findings related to the TUAS should be interpreted with caution.

A main conceptual framework for the TUAS was the idea that students perform better on tasks when they feel like they have higher self-efficacy. Self-efficacy is a person's belief they can be successful in a performing a certain behavior (Bandura, 1982). Understanding an individual's self-efficacy related to technology may help to explain more about why they prefer or are success in using certain types of technology. While the TUAS did not directly measure self-efficacy, it did measure usage and asked students to report their feelings about their ability to use certain types of technology. Students were asked if they often needed help to use technology, or if they preferred using certain types of technology.

In addition, there is a connection between the technology in a person's environment, their self-efficacy, and their behaviors. Individuals choose to engage in behaviors in which they believe they will be successful. If they are successful, they are reinforced for these behaviors, which then increases self-efficacy. This in turn makes it more likely that a person will engage in a behavior. Therefore, technology usage data is an important part of the TUAS as it may explain more information about environment and factors that influence the development of self-efficacy.

First, usage data were examined. Student scores for use of different types of technology were averaged for home and school, resulting in an average home and an average school usage score. These averages were then compared to student attitudes. It was hypothesized that students who used more technology at home and at school would type more. However, there was a very low correlation between average school or average home technology use and typing performance. This lack of a relationship means that students who more frequently used or had more access to technology did not type any more than their peers with reduced levels of technology usage.

There was limited variability in the responses on the survey items, which may have contributed to the results and a lack of any strong relationship. In examining the range and average of student responses to usage questions, many students tended to report very similar usage data. With this population, student use of cell phones at home tended to be high, while most other types of technology were reported to be rarely used at home. Student school use was reported to be fairly low overall.

There was also low correlations between school or home technology use and the 3 subscales on the TUAS. Therefore, student access to or use of technology at home and school did

not influence student perceptions of the usefulness of technology. Student technology use did not relate to how confident students were with using different types of technology, and previous technology use not relate to student preference for typing or handwriting. The strongest correlation was between home usage and Preference, but this correlation is considered to be weak.

There was a small negative correlation between average home technology usage and typing performance. There could be many explanations for this finding, such as the use of different technology at home to play games, but not necessarily for typing. Students may be playing games or engaging in other activities, but may not be typing or using skills that would translate to word processing. There is also a weak negative correlation between both total words typed and Preference on the TUAS. Further research may be needed to examine more detailed information about technology usage at school, and to strengthen the psychometrics of the TUAS to gain more information about technology use and typing preference.

Access to Internet

While not specifically a research question, data were gathered from students about their access to internet. Previous research by NCES suggested that students who reported having internet access scored higher on computer writing assessments. Furthermore, the current study was conducted in a rural school district with a high population of students receiving free or reduced lunch, making it less likely that these students would have access to resources such as internet. Students were asked if they had access to internet at home, and were given the option to choose yes, no, or not sure. A correlation examining the relationship between student internet access and typing and handwriting performance found no significant relationship. The

correlation among these relationships was very poor (i.e., r=0.05 for both). A correlation among internet access at home and the subscales on the TUAS also found no relationship (i.e., r=0.21 for Usefulness, r=0.21 for Preference, and r=0.23 for Confidence).

However, this data may suggest results contrary to data found in the NAEP assessments, as in that research students who reported having internet access scored higher than their peers. The influence of internet access on student performance on computer based assessments represents an area that should be researched in the future.

Limitations and Future Research

Psychometrics of the TUAS. One major limitation to this study was the psychometric properties of the TUAS, which is in the pilot testing phase of development. All results related to the TUAS should be interpreted cautiously as many of the reliability scores are considered to be in the moderate range. The reliability scores for the three subscales of the TUAS (Usefulness, Confidence, and Preference) range from 0.62 to 0.699. A strong measure should report a Cronbach's Alpha of at least 0.7 or higher, which would suggest that the items within each scale have a high internal consistency and are measuring the same construct. Since individual factor scores on the TUAS scores suggest moderate reliability, there is the possibility that results are due to error, and do not necessarily represent student responses.

To improve the reliability of the TUAS and subscales, the survey should be edited and more items added to scales to increase reliability. Now that the three subscales (i.e., Usefulness, Confidence, and Preference) have been identified, it may be easier to write items directly related to those factor areas. By editing current items and adding additional related items, the TUAS could be strengthened.

A major limitation of these data and any information gathered from a survey is that it was self-reported by students, and was not independently verified. Self-reported data for this survey may be confirmed by gathering information from parents, or having parents complete a list of their child's technology use at home. It also may be possible to confirm school usage data by conducting classroom observations.

Variation in Responses. Furthermore, there was a lack of variation in student responses in the sample. For example, students in this school are from the same rural community with similar socioeconomic backgrounds. In addition, students have been taught by the same classroom teachers and probably engaged in the same types of activities with technology. The school as a whole has specific technology resources available. Therefore, this sample may not represent individual variation in student experiences. Further testing of the TUAS should be conducted with a larger, more diverse sample to gather a variety of responses from students in types of community (rural vs urban), from a variety of SES levels, and having parents of varying education levels. While this expanded testing will improve the quality of data collected and the variety of student responses, it also will improve the quality of data collected and the variety of student responses.

Generalization. The participants in this study were students at a rural elementary school in a district with a high percentage (70%) of students considered to be economically disadvantaged (Tennessee Department of Education, 2012). Twenty five percent of participants in this study reported that they did not have Internet access at home. The results of this study may not generalize to more affluent or diverse populations. Demographics involved in this and previous research should be carefully considered as this study is focused on technology usage,

and students in more economically advantaged areas may have more access to technology, the internet, and other resources. NAEP data from previous writing assessments suggested that students who performed well on computer-based assessments were more likely to have internet access, to come from suburban schools, and to report higher levels of parental education (National Center for Educational Statistics, 2012; White, Kim, Chen, & Liu, 2015). Future research could expand the results of this study, and testing of the TUAS, to different populations.

Furthermore, since this study focused on students in third, fourth, and fifth grades, it cannot be expected that the results will generalize to the higher grades For example, students in higher grades may have had very different experiences with technology (positive or negative). In addition, more advanced students may have complete a keyboarding class. If so, their typing skills may result in much stronger typed stories. If more advanced students are more comfortable with and skilled in keyboarding and word processing, results of the same study may be reversed. However, previous research suggests that students with poor writing skills tend to continue to have difficulty in upper grades (Graham, McKeown, Kiuhara & Harris, 2012). It is not known if poor early typing skills continue to persist. It would be valuable to use this study as a launching point for a longitudinal study examining student writing and typing performance across several years and increasing grade levels.

There are additional demographic variables that may be worth examining. It may be beneficial to examine any influence that gender may have on word production. Previous research suggests that girls outperform boys on measures of writing achievement, which may explain some variation in student performance on written tasks (Pajares, 2003). It is not known if girls have better typing skills than boys. In addition, 91% of the students in the district are white. A

follow up to this study could include further pilot testing of the TUAS with a variety of diverse students from different ethnic and racial background. These students may have different levels of access to technology. In addition, any students who have a first language other than English may perform differently on writing and typing assessments than their peers.

In addition, it may be beneficial to examine differences in performance as it relates to student benchmark scores and participation in Response to Intervention tiers. It may be that students who do not receive intervention and are overall successful academically may be more successful at writing and typing. Students who struggle with reading, decoding, or spelling may be less automatic at writing and therefore may have more difficulty becoming fluent typers. They may focus more of their cognitive load on spelling or processing their thoughts. Examining the performance of students in tiered intervention may provide guidance for educators in designed effective interventions.

Type of Task. This study focused on a narrative writing task. While research has shown that narrative writing is appropriate for elementary students completing curriculum-based assessments, it may be helpful to gather information about other writing tasks, such as expository or argumentative tasks, as these often are the types of tasks students are asked to complete on state assessments. In addition, the results of study may provide some guidelines for comparing different typing programs for explicit instruction of typing skills, an area that has very limited previous research. The results of this study suggest that without any formal typing instruction, elementary students handwrite significantly more words than they type. Students could be asked to perform similar types of handwritten and typed tasks before and after participating in a program meant to teach typing, keyboarding, or other specific technology skills. Student word

production could then be examined to determine if the intervention was effective at teaching skills.

Summary and Applications

While further research may be needed to examine student attitudes toward technology and the effect that previous technology usage has on computer performance, this study did help provide more information about differences in handwritten and typed word production. The results of this study suggest that students type significantly more words than they handwrite on similar tasks. This finding suggests that there must be more explicit keyboarding instruction in schools, starting at younger ages. Unfortunately, there is essentially a non-existent body of research on the development of typing skills, and no information about specific keyboarding programs or how best to teach these skills to young students.

In addition, observational data from this study suggests that students need more explicit instruction in word processing, but also in other areas such as using email. It should not be assumed that 'digital natives,' who may have grown up with exposure to different types of technology, will actually have the typing skills necessary to excel in computer-based writing tasks.

This study also presents data that should be very concerning to all those involved in academic assessment of students. In many states, students are expected to complete state standardized tests starting at grade 3. The results of this study suggest that these students are not prepared to type responses to computer-based assessments. Furthermore, this study suggests that there is a difference between handwritten and typed responses which suggests that computer-based assessments may not be completely accurate in measuring a student's full academic

ability. In addition, scores on computer-based assessments may be affected by variables other than pure academic knowledge. Teachers and schools need to focus on basic word processing skills and explicit keyboarding skills to ensure that students are prepared for computer-based writing assessments. Most importantly, further research should be conducted on computer-based assessments to understand what variables may affect or confound student performance, and to determine if these assessments are accurately measuring student academic performance.

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Appendices

Appendix A

Informed Consent Letter

Typing, Writing, and Technology!

Parent Permission Form

I understand that the purpose of this study is for Ms. Chwat and Dr. McCurdy to learn more about the relationship between typing skills, use of technology, and writing skills (specifically the amount your child can write and the complexity of their writing). My child's performance and responses may help their classroom teacher and school to learn more about student needs related to typing and writing skills.

I understand that if I give my permission for my child to participate in this research project, he/she will be asked to write two essays during school at New Market Elementary, which should take about 5 minutes each. My child will also take a short typing test, and will take a short survey asking them about how often they use certain types of technology at home and at school, and what they think about their skills with technology. I understand that if I give my permission my child's work might be used in articles and presentations. Participation in the study poses no known risks to my child, my child's participation will be completely confidential, and my child's real name will never be used.

I understand that my child's participation is completely voluntary. If I change my mind, I can tell Ms. Chwat or Dr. McCurdy at any time and they will not use my child's examples.

If I have any questions about my rights as a research participant, I may contact the University of Tennessee Office of Research, whose job is to take care of research participants, at (865) 974-7697.

I give permission for my child to participate.

Child's name (please print)

Parent/Guardian's Name (please print)

Parent/Guardian's Signature Date

IRB NUMBER: UTK IRB-16-03102-XP IRB APPROVAL DATE: 08/15/2016 IRB EXPIRATION DATE: 08/14/2017

Appendix B

Youth Assent Form

Typing, Writing, and Technology!

Hello, my name is Carly Chwat. I'm a researcher at the University of Tennessee. Your guardian/parent and your teacher say you might be willing to help me with a research project. If you agree to help me, for the next few months we are going to work on a few things together. We will take a short typing test. We will also work on two essays that will take about 5 minutes each. I will also have a survey for you to fill out that will ask you about some different types of technology that you use at home and at school, and what you think about using technology.

Are you willing to help me with this project? (circle one) YES NO

If you chose yes, I think you will find this fun to do. If you decide that you don't want to do this anymore, all you have to do is tell me.

I appreciate your help!

If you sign this form, it means you have decided to help me with this research project.

Signature of student

Signature of researcher

IRB NUMBER: UTK IRB-16-03102-XP IRB APPROVAL DATE: 08/15/2016 IRB EXPIRATION DATE: 08/14/2017

Appendix C

Survey of Usage of and Attitudes toward Technology

Part 1-Use of Technology at Home

- Think about what you have and use **at home**
  - Please circle number of days for each question that best applies to you.

In the last week, how many days did you use?	Number of days:
Computer (Laptop or Desktop)	0 1 2 3 4 5 6 7
Game Console (like an Xbox, Wii, Playstation)	0 1 2 3 4 5 6 7
Handheld Gaming Device (like a DS, PS Vita)	0 1 2 3 4 5 6 7
Tablet or E-Reader (like a Kindle, Nook, iPad)	0 1 2 3 4 5 6 7
Cell phone or MP3 Player	0 1 2 3 4 5 6 7
Other:	0 1 2 3 4 5 6 7
Other:	0 1 2 3 4 5 6 7

Part 2-Use of Technology at School

- This chart will look like the one you just did, only now think about what you use **at school.**

Please circle number of days for each question that best applies to you.

In a week, how many days did you use?	Number of days:
Computer (Laptop or Desktop)	0 1 2 3 4 5 6 7
Game Console (like an Xbox, Wii, Playstation)	0 1 2 3 4 5 6 7
Tablet or E-Reader (like a Kindle, Nook, iPad)	0 1 2 3 4 5 6 7
Cell phone or MP3 Player	0 1 2 3 4 5 6 7
Other:	0 1 2 3 4 5 6 7
Other:	0 1 2 3 4 5 6 7

Part 3-Attitudes toward Technology

Please put an X in the column under the answer choice that is most like you for each question.

Here is an example of how to answer this question:

	Not me	Sometimes me	Often me	Always me
I like pizza.			X	

	Not like me	Sometimes like me	Often like me	Always like me
1. I use a lot of different kinds of technology at home.				
2. The technology I use at school helps me learn.				
3. I help my classmates or teacher use technology when they have trouble.				
4. I use a lot of different kinds of technology at school.				
5. I am good at using technology.				
6. The technology I use at home helps me be better at using technology at school.				

7. I think that knowing how to type well is useful.				
8. I am confident about using technology.				
9. I get better grades on I things I type than I things I handwrite.				
10. I would rather handwrite than type something for school.				
11. I do better at school when I type things instead of handwriting them.				
12. I think that knowing how to use technology is important.				
13. I do not like using technology.				
14. I think it's hard to use technology.				
15. I often need help from my teacher or friends when we use technology at school.				
16. I use technology at home to play games.				
17. I use a computer or laptop at home to type my homework or assignments for school.				
18. I use a computer or laptop to type assignments during school.				

19. I use my computer or laptop to watch TV or movies.				
20. I get nervous or worried when I'm using technology.				
21. I am good at typing with a keyboard.				

Please put an X in the box that best answers this question.

	Yes	Not Sure	No
I have Internet access at home.			

Appendix D

Example of writing prompt (handwritten response)

The best thing about school is…

Appendix E

Survey Administration Script

1. Introduce researchers. Say "Hello! We are (introduce researchers present) and we are students at the University of Tennessee. We're handing out papers. Please leave them face down for now. (Give each student a paper copy of the survey, face down, and a copy of the student assent form, face down.)

2. We are here today because we need your help for a research project that we're doing. We want to know about your writing and typing skills and how much technology you use at home and school. So today we are going have you answer a survey with questions about your technology use and then we'll have you write a story and type a story. This shouldn't take too much time and we'll be finished in about 40 minutes.

3. Give them the following instructions:

"On your desk, you have a copy of a research permission form that we would like you to sign. (Show them a copy of the form). Your teacher wants everyone to participate in our project but we need your permission to use your stories and survey information. We will not use your name ever. Before we leave the building, we are going to give you a number code and remove your name from all our stuff. So, if you will let us use your information for our project, please circle yes. If you do not want us to use your information, you can circle no. Once you have circled yes or no, please sign your name on the line. (pause to allow students to complete these). Leave these forms on your desk and we'll get them in a minute."

"Now, turn over the other piece of paper. It's the survey about your technology use. This is not a test. There are no right or wrong answers. We will do this survey together but please read each question carefully along with me. The answers you give are important, so please answer the questions truthfully and the best that you can. Remember, the survey will be anonymous. We'll remove your name later. No one will ever be able to tell that your answers came from you. Does anyone have any questions?" Great!

"The first part of this survey will ask you some questions about how many days during a *normal* week that you use different types of technology at home. So, think about what you have at home and how much you use it. Circle the number of days for each question that best applies to you. Any questions?"

"Okay, let's get started!

"How many days in a week do you use a desktop computer or laptop at home? Remember this is only at home. Circle that number now." If you don't have a computer or laptop at home, you would circle 0 (you can repeat this after every few items to remind them)

"How many days in a week do you use a game console, like an Xbox, Playstation, or Wii? Circle that number now."

"How many days in a week do you use a handheld gaming device, like a DS, PS Vita?

"How many days in a week do you use a Tablet or E-Reader, like a Kindle, Nook, iPad?

"Did you use something that's not listed? Write the thing that you used in the space where it says "other," and circle the number of days last week that you used this type of technology."

"Now think about the technology that you use at school."

"How many days in a week do you use a desktop computer or laptop at school?" Remember this is only at school. Circle that number now." If you don't have a computer or laptop at home, you would circle 0 (you can repeat this after every few items to remind them)

"How many days in a week do you use a game console, like an Xbox, Playstation, or Wii?"

"How many days in a week do you use a Tablet or E-Reader, like a Kindle, Nook, iPad?"

"Did you use something in the last week at school that's not listed? Write the thing that you used in the space where it says other, and circle the number of days last week that you used this type of technology."

"The last part of this survey has several different sentences for you to read and asks you if these sentences are not you, sometimes you, often you, or always you. There is a practice question that we can do together. This sentence says "I like pizza." If pizza is your absolute favorite and you ***always*** want to eat it, you would put an X in the box that says "always like me." If you really don't like pizza and ***never ever*** want to eat it, you would put an X in the box that says "never like me." Write an X in the box that best describes you now."

[Administrators can skip directions if students understand.]

Let's go through the rest of the items together.

"1. I use a lot of different kinds of technology at home. Put an X in the box that best describes you.
2. The technology I use at school helps me learn. Put an X in the box that best describes you.
3. I help my classmates or teacher use technology when they have trouble. Put an X in the box that best describes you.
4. I use a lot of different kinds of technology at school.
5. I am good at using technology.
6. The technology I use at home helps me be better at using technology at school.
7. I think that knowing how to type well is useful.
8. I am confident about using technology.
9. I get better grades on I things I type than I things I handwrite.
10. I would rather handwrite than type something for school. Put an X in the box that best describes you.
11. I do better at school when I type things instead of handwriting them.
12. I think that knowing how to use technology is important.

13. I do not like using technology.

14. I think it's hard to use technology.

15. I often need help from my teacher or friends when we use technology at school.
16. I use technology at home to play games.
17. I use a computer or laptop at home to type my homework or assignments for school.

18. I use a computer or laptop to type assignments during school.
19. I use my computer or laptop to watch TV or movies.

20. I get nervous or worried when I'm using technology.

21. I am good at typing with a keyboard..."

"We will now collect your papers. Thank you for doing that part of our project!"

4. Collect surveys and assent forms from students.

Now we are passing out another piece of paper. Leave it face down until I tell you to turn it over.

When all are passed out, tell the students to "Turn over your paper."

Appendix F

Writing Prompt Data Collection Script-**Handwritten** Response

1. Give them the following instructions:

"I want you to write a story. I am going to read the first few words of the story to you first and then I want you to write a story about what happens. You will have 1 minute to think about the story you will write, and then you'll have three minutes to write it. Do your best work. If you don't know how to spell a word, you should guess. Use the words written at the top of your paper as your first sentence. Are there any questions? For the next minute think about….. (read story starter)." Begin timing.

2. If students start writing, instruct them to wait until you tell them to begin writing.

3. After 30 seconds say, "You should be thinking about…"

4. After 1 minute, say, "Start Writing." (Restart the stop watch.) Walk around the classroom to ensure the students are writing.

5. After 90 seconds, say, "You should be writing your story."

6. At three minutes, say "Stop and put your pencil down."

Now, get out your laptop and turn it on. You should have an email from your teacher titled "STORY FOR RESEARCH PROJECT." Open the document and save it to your computer.

Appendix G

Writing Prompt Data Collection Script-**Typed** Response

1. Give them the following instructions:

"I want you to type a story. I am going to read the first few words of the story to you first and then I want you to type a story about what happens. You will have 1 minute to think about the story you will type, and then you'll have three minutes to type it. Do your best work. If you don't know how to spell a word, you should guess. Use the words written at the top of your paper as your first sentence. Are there any questions? For the next minute think about….. (read story starter)." Begin timing.

2. If students start typing, instruct them to wait until you tell them to begin writing.

3. After 30 seconds say, "You should be thinking about…"

4. After 1 minute, say, "Start Writing." (Restart the stop watch.) Walk around the classroom to ensure the students are writing.

5. After 90 seconds, say, "You should be writing about…."

6. At three minute, pause the stopwatch and say "Okay, everyone stop and take your hands off the keyboard."

Once everyone has stopped typing, tell them….

Save your story to your computer. Now, email it to

Appendix H

Survey of Usage of and Attitudes toward Technology Administration Integrity Checklist

	Survey of Usage of and Attitudes toward Technology Administration Integrity Checklist	✔
1	Introduce researchers.	
2	Give each student a paper copy of the survey.	
3	Give each student a paper copy of the assent form.	
4	Read directions starting “this is not a test”.	
5	Ask if there are any questions.	
6	Read directions starting “on your desk you have a permission form”.	
7	Read directions starting “now turn your survey face up”.	
8	A. Read question about computer use at home.	
	B. Read question about game console.	
	C. Read question about tablet usage.	
	D. Read question about other technology usage.	
9	A. Read question about computer use at school.	
	B. Read question about game console.	
	C. Read question about tablet usage.	
	D. Read question about other technology usage at school.	
10	Read directions starting “the last part of this survey”.	
11	Read question 1	
12	Read question 2	
13	Read question 3	
14	Read question 4	

15	Read question 5	
16	Read question 6	
17	Read question 7	
18	Read question 8	
19	Read question 9	
20	Read question 10	
21	Read question 11	
22	Read question 12	
24	Read question 13	
25	Read question 14	
26	Read question 15	
27	Read question 16	
28	Read question 17	
29	Read question 18	
30	Read question 19	
31	Read question 20	
32	Read question 21	
33	Say “we will now collect your papers” and collect papers.	
34	Thank students for participating!	

Appendix I

Writing Prompt Data Collection Script-Handwritten Response Integrity Checklist

	Writing Prompt Data Collection Script-Handwritten Response Integrity Checklist	✔
1	Give each student a paper copy of the story starter, face down.	
2	Read directions starting “I want you to write a story”.	
3	Ask if there are any questions.	
4	Begin timing.	
5	After 30 seconds say, “You should be thinking about	
6	After 1 minute, say, “Start Writing.	
7	Restart stopwatch.	
8	After 90 seconds, say, “You should be writing about	
9	At three minutes, say “Okay, it’s 3 minutes...	
10	At five minutes say, “Stop and put your pencil down.”	
11	Collect papers from students	
12	Thank students for participating!	

Appendix J

Writing Prompt Data Collection Script-Typed Response Integrity Checklist

	Writing Prompt Data Collection Script-Typed Response Integrity Checklist	✔
1	Make sure that each student has a laptop.	
2	Read directions starting “I want you to type a story”.	
3	Ask if there are any questions.	
4	Begin timing.	
5	After 30 seconds say, “You should be thinking about	
6	After 1 minute, say, “Start Writing.	
7	Restart stopwatch.	
8	After 90 seconds, say, “You should be writing about	
9	At three minutes, say “Okay, it’s 3 minutes...	
10	At five minutes say, “Stop and put your pencil down.”	
11	Instruct students to save their documents.	
12	Thank students for participating!	

Appendix K

Table 3

Item Total Statistics

Item	Scale mean if deleted	Scale variance if deleted	Cronbach's Alpha if deleted
2: The technology I use at school helps me learn.	11.69	7.98	0.642
3: I help my classmates or teacher use technology when they have trouble.	12.22	7.897	0.633
6: The technology I use at home helps me be better at using technology at school.	12.19	7.347	0.666
7: I think that knowing how to type well is useful.	11.76	7.015	0.633
12: I think that knowing how to use technology is important.	11.34	8.311	0.646
9: I get better grades on I things I type than I things I handwrite.	5.19	4.049	0.560
10: I would rather handwrite than type something for school.	4.94	3.596	0.645
11: I do better at school when I type things instead of handwriting them.	5.10	4.136	0.613
14: I think it's hard to use technology.	10.23	2.831	0.582
15: I often need help from my teacher or friends when we use technology at school.	10.63	2.216	0.487
5: I am good at using technology.	10.41	2.391	0.528
20: I get nervous or worried when I'm using technology.	10.15	2.736	0.586

Appendix L

Table 4

Factor Analysis Rotated Component Matrix

	Component		
Item	1	2	3
7	0.726		
12	0.669		
6	0.643		
3	0.637		
2	0.635		
15		0.768	
5		0.702	
14		0.630	
20		0.604	
10			0.797
9			0.789
11			0.728

Appendix M

Table 5

TUAS Subscales

Subscale Name	Items	Reliability
Usefulness	2. The technology I use at school helps me learn.	0.699
	3. I help my classmates or teacher use technology when they have trouble.	
	6. The technology I use at home helps me be better at using technology at school.	
	7. I think that knowing how to type well is useful.	
	12. I think that knowing how to use technology is important.	
Preference	9. I get better grades on I things I type than I things I handwrite.	0.696
	10. I would rather handwrite than type something for school.	
	11. I do better at school when I type things instead of handwriting them.	
Confidence	5. I am good at using technology.	0.620
	14. I think it's hard to use technology.	
	15. I often need help from my teacher or friends when we use technology at school.	
	20. I get nervous or worried when I'm using technology.	

Appendix N

Table 7

Correlation between home and school technology usage and TUAS subscales

	1	2	3	4	5	6
1. Home Usage Average	1					
2. School Usage Average	.194	1				
3. Total Words Typed	-.101	.047	1			
4. Usefulness	.186	.077	.116	1		
5. Preference	.260	-.066	-.077	.195	1	
6. Confidence	.073	-.086	.043	-.010	.141	1

Vita

Carly Ann Chwat was born in Michigan and lived in Michigan, New York, and Washington before completed high school in Georgia. She graduated from The University of Georgia in 2012 with a B.S. in Psychology and a minor in Child & Family Development. She began her graduate career at the University of Tennessee School Psychology Ph.D. Program in August of 2013. In 2015, she earned an M.S. in Applied Educational Psychology. She will serve as an intern in the 2017-2087 Pre-doctoral Professional Psychology Internship Training Program with the Tennessee Internship Consortium in Psychology in Sweetwater City Schools in Tennessee, and will complete her doctoral requirements in August 2018.