

HANDWRITING IN YOUNG ADULTS IN AN ERA OF TECHNOLOGICAL
ADVANCEMENTS

by

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December, 2015

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Abstract

The purpose of this study was to investigate handwriting and technology as methods for note-taking in the post-secondary classroom, handwriting in daily life, and perceptions of handwriting instruction, both print and cursive, in young adult post-secondary students. Based on the current use of handwriting for note-taking and personal tasks in young adults, is handwriting an important skill which should continue to be taught in the primary classroom? The study utilized a web-based survey given to current students at East Carolina University. Question formats included Likert scale, sorting, multiple choice and open ended. The survey was distributed to a random sample of 1800 East Carolina University students, 106 young adult responses were analyzed. Results revealed handwriting is the most common note-taking method, used by 72.7% of students for 75-100% of the classroom experience. Furthermore, participants reported handwriting instruction is an important component of the primary education. Statistical chi square analysis revealed no statistically significant correlations between groups of post-secondary students based on gender and handwriting grasps. Occupational therapists and teachers can utilize this information to consider the importance of continuing to support handwriting instruction and making it a greater priority in the primary classroom as handwriting

was found to have educational and personal relevance while achieving a post-secondary education.

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ADVANCEMENTS

A Thesis

Presented To the Faculty of the Department of Occupational Therapy
East Carolina University

In Partial Fulfillment of the Requirements for the Degree
Master of Science in Occupational Therapy

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ACKNOWLEDGEMENTS

My sincere appreciation cannot begin to express how thankful I am for the following individuals. Dr. Denise Donica for her supportive mentorship throughout the entire research process; and Dr. Anne Dickerson and Dr. Leonard Trujillo for their constructive recommendations. The East Carolina University Survey Review and Oversight Committee, Handwriting Without Tears instructors and my fellow graduate students for making my pilot study possible. For the willing East Carolina University students who participated in my survey without whom my research would not have been possible. Lastly, I thank my parents for providing constant support and encouragement to aim high in my educational endeavors and never give up. Thank you for providing me the tools to believe in myself and persevere.

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CHAPTER 1: INTRODUCTION

Computers have been implemented into society allowing students to type letters and reports, but handwriting is still relied on for writing personal notes, messages, completing forms and maintaining records (Schneck & Amundson, 2010). Handwriting instruction for print and cursive in primary classrooms has been curtailed by state mandated tests and limited instruction time in the classroom based on curriculum requirements (Supon, 2009). However, despite changes in the design and implementation of curriculums, handwriting is still a component part within primary education for young students.

Supon (2009) noted literacy is an important skill for individuals to survive in society, acquiring appropriate literacy begins when students learn to read, write, listen and communicate effectively through classroom instruction. Thus, without handwriting instruction and students actively participating in handwriting tasks, how could literacy levels of students be impacted? Graham, Harris, and Fink (2000) determined handwriting influences a student's ability to write, which could further influence a student's academic achievements; handwriting instruction benefits a student's ability to write at a higher level. McGee and Richgels (2000) concluded writing and reading skills develop in parallel; if students were introduced to technology first how would reading skills be impacted? Implications from a dependence on technology in the classroom could impact student success at the primary levels and lead to continued challenges as the student progresses through his or her education.

Handwriting battles technology as a possible form of communication chosen by individuals. Developments made in technology will continue to influence the preferred classroom note-taking method among post-secondary students. Laptops, smartphones and tablets have been the most popular devices owned among the young adult student population

(Marketing Charts Staff, 2013). The past few decades have revealed numerous changes in technology which have also influenced university campuses (Mogey, Sarab, Haywood, van Heyningen, Dewhurst, Hounsell, & Neilson, 2008). Universities now boast resources such as computer labs and social computing spaces or cybercafés for students to utilize while pursuing their education (Mogey et al., 2008). Fried (2008) reported 64.3% of students used laptops in at least one class over a post-secondary semester, students who used laptops used them 48.7% of the class period. The increased access to computers and society's reliance on the technology may lead some educators to assume handwriting is no longer a relevant and necessary part of early primary instruction (Cahill, 2009).

Problem Statement

As primary teachers instruct students in handwriting, when a student has difficulty with the task, the first point of contact may be an occupational therapist (Schwellnus, et al., 2012). If a student is unable to recognize letterforms and how letterforms represent the written language, the child should not be expected to write (Schneck, & Amundson, 2010). Typically developing children are often found to exhibit a lack of effort when handwriting is not equivalent to peers (Zwicker, & Hadwin, 2007). An occupational therapist may observe the student and/or meet with the student for an evaluation to determine the root of the problem. The therapist is responsible for the direction of treatment, either to focus on addressing the underlying issues impacting a student's handwriting or focus on correcting the specific handwriting errors (Hoy, Egan, & Feder, 2011). Utilization of occupational therapists in the educational system to address handwriting difficulties is responsible for a majority of the caseload seen by occupational therapists in the school system (Hoy, et al., 2011). Knowledge about the use and importance of handwriting currently, despite continued technological advancements, will help determine the

significance of handwriting within the occupation of education for children. This knowledge can influence whether handwriting should continue to be stressed in primary education and occupational therapy sessions with young students for continued functional use.

Although handwriting may be viewed as a key developmental skill for young students, it is not clear how handwriting is used in the classroom among young adults' pursuing a post-secondary education. Handwriting is a critical skill for young students, it enables communication and a method to articulate thoughts, feelings and ideas (Chu, 1997). Although research has previously investigated handwriting at the primary level, few studies have investigated the impact of handwriting and technology together in a post-secondary student population to determine the amount of time handwriting is used for note-taking and/or personal use outside the classroom (Dennis, & Swinth, 2001; Feder, & Majnemer, 2007; Moge et al., 2008).

Purpose of the Study

The primary investigator's purpose for this survey study was to collect data from post-secondary students to determine preferred note-taking methods in the post-secondary classroom, for what tasks and how often handwriting is used for personal matters, and opinions towards continued primary handwriting instruction. This information can be used to inform occupational therapists as well as primary and secondary teachers in how relevant handwriting is to current post-secondary students. Understanding the role and importance of handwriting and technology in the post-secondary classroom will enable greater support for the purpose and context of handwriting instruction at the primary level. Is it a developmental skill important in the primary and secondary education system only, or is it a lifelong critical skill to have, especially when aspiring towards a post-secondary education? The current study moves beyond traditional

investigations of handwriting with primary students by investigating a population of undergraduate and graduate students at a public university. The objective was to examine the effectiveness and importance of handwriting while the role of technology continues to expand. This investigation was meant to determine if the use of handwriting continues to be important among post-secondary education students.

Significance of the Study

As new technology continues to develop and classrooms continue to adapt, it is important to understand the role of handwriting through this time of technological growth. A common classroom at the post-secondary level contains a combination of projection equipment, internet access, and computer-based instruction materials not limited to PowerPoint and videos (Fitch, 2004). This study will help to understand the role of handwriting for young adults inside and outside the post-secondary classroom which may influence the direction of future primary handwriting instruction. As a student progresses throughout the educational system beyond primary school, students are required to understand more information that is presented in ways which are challenging to process, both lecture and expository text (Thomas, Iventosch, & Rohwer, 1987; Mulcahy-Ernt & Caverly, 2009; Snow, 2002). The use of handwriting and/or note-taking in general is one way in which students may find retention of information and a full understanding of information to be more adequate for the learning environment. This investigation will help professionals understand what methods of note-taking post-secondary students are using, how often methods are being used and what methods are most effective. This study will support limited research in the post-secondary student population investigating technology and handwriting simultaneously

CHAPTER 2: LITERATURE REVIEW

Importance of Handwriting

Handwriting is not a leading focus within literacy education today; yet handwriting has been shown to be important in a student's ability to write compositions (Medwell, & Wray, 2014; Cahill, 2009). Curriculums include handwriting instruction, but not to the same extent as seen in the past. Common Core State Standards have been adopted in most states, yet these standards do not include all which can or should be taught at specific grade levels related to handwriting skills (National Governors Association Center for Best Practices & Council of Chief State School Officers, 2010). There are educators who take for granted how closely handwriting ties into a student's academic achievement (Berninger et al., 2006). Even if students do not expect to use handwriting as a primary mode of communication, the instruction and practice of the skill helps support a student's academic achievement at the primary level (Cahill, 2009). If school systems are consistent with instructional methods and provide ample time to practice the skill, it could help students establish handwriting as a skill to be used for effective communication in an educational and social setting (Asher, 2006).

Handwriting is both a form of communication and an important life skill for individuals to utilize which deserves more attention than what is currently received. (Feder, Majnemer, & Synnes, 2000; Feder, & Majnemer, 2007; Taras, Brennan, Gilbert, & Reed, 2011). In other words, handwriting performance is a critical component to student success making it a concern for occupational therapy practitioners, specifically those working in a school system. Referrals to occupational therapy within the school are commonly the result of problems observed in regards to handwriting performance, a majority of interventions are aimed at improving handwriting performance for a student (Hoy et al., 2011; Taras et al., 2011).

Handwriting and Occupational Therapy

When primary teachers recognize a student is not demonstrating age appropriate handwriting skills, the teacher may decide to support a student's development with classroom interventions. If a student has illegible handwriting or has a slow writing fluency, he or she may struggle keeping up with classmates (Press & Banton, 2007). Between 10-20% of students have legibility concerns. Such difficulties can challenge a student's overall academic performance as well as self-esteem, relationships, personal perception and peer perception of the student's abilities (Schwellnus et al., 2012; Press & Banton, 2007). Primary students may begin to lose interest in school if their handwriting continues to place them at a disadvantage to fellow classmates consistently (Press & Banton, 2007). After a student has been identified for having poor legibility and has had no success with classroom interventions to produce a positive change, the student may be referred to occupational therapy services (Hoy et al., 2011). However, part of the root of handwriting difficulties for students arises from inadequate instruction students receive through regular education within the classroom. Classroom teachers may not have been provided the proper knowledge to instruct students on handwriting, or teachers may lack knowledge of handwriting development, which can lead to poor quality instruction (Graham, Harris, Mason, Fink-Chorzempa, Moran, & Saddler, 2008; Donica, Larson, & Zinn, 2012). Handwriting instruction is not as important relative to other classroom content as it was years ago (Kiss, 2007). Asher (2006) revealed the importance of consistent instruction in handwriting on how to form letters, the grade levels should be consistent.

Occupational therapy practitioners have the ability to provide interventions directly to the student, or the practitioner can consult with the teacher on solutions and interventions to implement in the classroom (Hoy et al., 2011). Occupational therapy practitioners who interact

with students' daily need to thoroughly understand what factors influence handwriting performance. This knowledge will enable the occupational therapy practitioners to better accommodate and help students improve handwriting skills where deficits and impairments may lie (Dennis & Swinth, 2001).

Occupational therapy practitioners may address kinesthesia, motor planning, eye-hand coordination, fine motor control, visual-motor integration, in-hand manipulation, musculo-skeletal components, proprioception, sensory awareness, sustained attention, thumb opposition, open web space, isolated finger movements, and adequate palmar arches during a treatment session to encourage improved handwriting in a young student (Asher, 2006; Feder & Majnemer, 2007; Denton, Cope & Moser 2006). The multifaceted skill of handwriting requires thoughtful consideration from the occupational therapist in order to address where students might be having difficulties and how best to assist them in achieving success in their educational endeavors. Cornhill and Case-Smith (1996) suggest eye-hand coordination is an essential component of handwriting; one to be considered when a student is facing challenges with handwriting. Visual motor skills, such as copying and in-hand manipulation for translation and rotation abilities, were also found to be predictive in identifying students with poor handwriting skills and recognized as areas for improvement (Cornhill & Case-Smith, 1996). The task of handwriting is made up of component parts required for a student to become successful, which influence one's legibility, speed and accuracy of handwriting. Early complementary instruction has been shown to improve a student's writing performance if he or she experience poor handwriting (Berninger et al., 1997). Students with additional instruction or intervention will be more likely to overcome their deficits in the classroom (Graham et al., 2000; Feder & Majnemer, 2007).

Many students faced with challenges in handwriting do not qualify for special education or related services, which include occupational therapy, to address their difficulties (Kiss, 2007). Students need to be encouraged to practice the skill of handwriting. Practicing motor production of letters will help the students make handwriting automatic in their minds allowing them to focus on other educational tasks (Asher, 2006). Occupational therapy practitioners in the school system should be able to understand the initial method of instruction a student has received for handwriting as well as identify the therapeutic needs of the student being referred (Asher, 2006). Handwriting instruction should involve a fun and easy to administer program teachers are capable of carrying out weekly (Kiss, 2007). Denton et al., (2006) found therapeutic practice which is carefully structured and implemented with motor learning principles is effective at improving handwriting with typically developing children who experience handwriting difficulties. Handwriting instruction requires many parts to be successful including stroke work to correctly form letters, instruction on proper formation of letters, and continued practice (Penhorwood, 2012).

The concern for occupational therapy practitioners in the school system is that between 30-60% of the school day focuses on fine-motor activities, predominantly handwriting (McHale & Cermak, 1992; Hoy et al., 2011; Lifshitz & Har-Zvi, 2015). Furthermore, 10 to 30% of young students experience difficulty with handwriting; leading handwriting to be the most common reason for referral to occupational therapy as these students require additional time to complete assignments which may affect academic performance and set students apart from peers (Hoy et al., 2011). Handwriting is an essential life skill in young students, yet 10 to 34% of students fail to master handwriting (Schwellnus et al., 2012). The therapist must remember to consult with

the team of teachers, parents and student, to influence the intervention plan to create one which is both meaningful and effective for the individual student (Hoy et al., 2011).

Development of Handwriting in the Young Student

Handwriting grasp has been researched from different perspectives to determine the effectiveness and efficiency of each grasp in order to pinpoint an optimal grasp for individuals to utilize. Often studies have investigated the relationships between handwriting grasp and legibility, speed, and minimizing fatigue (Schwellnus et al., 2012; Shah, & Gladson, 2015; Dennis & Swinth, 2001; Koziatek & Powell, 2003). Knowledge about the grasp patterns which produce the best results, in regards to legibility, speed and fatigue can help therapists define what grasp patterns should be considered acceptable when working with a student to develop fine motor writing skills. As students are taught handwriting, it is important the optimal challenge point, or functional difficulty of the task, increases to encourage continued learning for the student (Asher, 2006).

As a leader in grasp development, Erhardt (1994) provided information on the development of primitive handwriting grasps beginning as early as one year in children with a palmar supinate grasp, achieved by the use of a simplified fist around the writing utensil. A child will progress through primitive grasps, transitioning to a digital pronate grasp between 2 and 3 years. The child will grasp the utensil proximally with a pronated forearm, straight wrist, and stabilization of the pencil with all fingers and the thumb (Erhardt, 1994). The third developmental grasp is the static tripod which presents between 3½ and 4 years. The forearm will be supinated, the wrist remains straight and stabilizes as the hand moves as a unit. The thumb, index and long finger will show crude approximation (Erhardt, 1994). The final developmental grasp is the dynamic tripod, which has traditionally been viewed to be the optimal

and most preferred grasp pattern for handwriting performance (Dennis & Swinth, 2001; Shah & Gladson, 2015). The dynamic tripod requires forearm supination, slight wrist extension and metacarpophalangeal joint stabilization for proximal interphalangeal movement. The ring and small fingers will flex to form a stable arch and the thumb, index and long fingers will engage in opposition (Erhardt, 1994).

Dennis and Swinth (2001) investigated handwriting legibility in fourth graders during long and short writing assignments, concluding more challenging writing tasks often led students to revert to engaging in an atypical grasp pattern. A significant difference between letter legibility scores was found on short and long term tasks as a result of reverting to the atypical grasp pattern. Conversely, handwriting grasp was not found to influence handwriting legibility in another study which concluded handwriting grasp did not significantly influence speed or legibility (Shah & Gladson, 2015). Therefore, it is unclear how an individual's grasp may influence legibility as past research has found contradicting results. Further research concludes the grasp of choice for a student does not affect the accuracy of graphomotor control (Asher, 2006; Koziatek & Powell 2003). When fourth graders were asked to complete the Children's Handwriting Evaluation Scale (CHES), grasps were identified as one of four different mature grasp patterns or an immature grasp pattern (Phelps & Stempel, 1987; Schwellnus et al., 2012). Results revealed no effect between grasp pattern and legibility or speed of handwriting (Schwellnus et al., 2012; Dennis & Swinth, 2001). Previous research reveals the dynamic tripod may not be the only beneficial and effective handwriting grasp for students, which further supports the notion to not change a student's grasp after second grade due to the added stress it can trigger (Shah & Gladson, 2015). The dynamic tripod and quadrupod, and lateral tripod and quadrupod, included in this research survey, are all considered mature grasp patterns (Koziatek

& Powell, 2003). The four finger grasp was unable to be concluded as a mature or immature grasp and the interdigital grasp is not considered to be a mature handwriting grasp (Koziatek & Powell, 2003).

As students' progress through the educational system, the demands and expectations for handwriting increase and students are expected to write for extended periods of time (Dennis & Swinth, 2001). During one assessment of a research study, the dynamic tripod was the most prevalently used grasp pattern; however, 20% of the sample changed their grasp in the middle of the study (Schwellnus et al., 2012). As students are asked to write more, demands placed on the hand and wrist increase and can lead to a change in grasp to accommodate discomfort or fatigue. Students not only experience fatigue with longer duration tasks but recognize handwriting becomes less organized and control of the writing utensil weakens (Summers & Catarro, 2003).

Handwriting and the Brain

New evidence suggests the link between handwriting and continued educational development and achievements runs deep. When a person writes, the activation which occurs in parts of the brain triggers mental stimulation (Konnikova, 2014). Activation in the brain resulting from freehand writing triggers brain activity in the same areas where adults have brain activation when engaging in reading and writing tasks (Konnikova, 2014).

Research has found functional specialization, the tendency for areas of the brain to respond more to one category of stimulus than others, is heavily prevalent in the adult brain (James, 2010). Functional specialization is thought to be the result of experience, and functional specialization has been heavily linked to single letter formation. Due to functional specialization, when individuals receive adequate amounts of exposure and practice with native

characters they will be able to easily and efficiently process the characters (James & Atwood, 2009).

Writing is not purely a motor or visual activity (Berninger et al., 2006). In some brain regions, activation was affected after writing and typing training, implying activation in brain regions may be more likely to respond with any motor experience (James & Atwood, 2009). However, the brain activation seen when students type is significantly weaker than what is seen with handwriting (Konnikova, 2014). There are individual differences in students who are learning to print with a pen, write cursive or type on a keyboard. All three methods of recording information initiate slightly different pathways (Berninger et al., 2006). The effort required to engage brain motor pathways with writing is beneficial in learning and acquiring the skill (James & Engelhardt, 2012). Knowing the brain is used in a slightly different capacity for each task may provide justifiable evidence and researched support for the importance of including all three in primary school curriculums.

The task of spelling initiates the frontal lobe, which allows a student to more easily access his or her vocabulary, word meaning, and concepts to allow writing and ideas to connect (Penhorwood, 2012). Further investigations into the brain's functioning have shown single letter perception heavily occurs in the ventral visual cortex, but letter strings may be processed more like actual words. This conclusion was made based on discovering areas specialized for letter strings in the brain are located near the visual word form area (VWFA) (James, James, Jobard, Wong, & Gauthier, 2005). The response to letter strings is far less intuitive than the response to single letters seen in the left fusiform gyrus (James et al., 2005). The activation occurring in the brain with spelling and letter formation will enhance a student's learning within the classroom environment. Since handwriting encourages greater brain activation it will help prime students

for better attention and focus on the material being taught when taking notes. Overall, the implications for brain activation with handwriting are prevalent, and more pronounced than those observed when typing.

Student Note-Taking

Research has begun to investigate commonalities among different groups of students' abilities and practice of taking notes. For instance, it has been recognized females take more extensive notes than males and those with a higher language comprehension take more extensive notes than those with lower language comprehension rates (Reddington, Peverly, & Block, 2015). Gender is not the only predictor in the quality of notes a student produces. A student's transcription fluency, reading comprehension, listening comprehension, and handwriting speed can also impact note-taking (Peverly & Sumowski, 2011; Peverly, Garner, & Vekaria, 2014).

Furthermore, low verbal males and females take notes similar in quality, but high verbal females take more extensive notes than high verbal males (Reddington, et al., 2015). Investigations have shown females have faster handwriting speeds and higher language comprehension (Reddington et al., 2015). From these findings, it can be inferred gender differences do exist in note-taking. Reading comprehension and listening comprehension are also highly correlated, which can influence students when detecting what is important to record to ensure a greater quality of notes while reading and listening to lectures (Peverly & Sumowski, 2011). Handwriting speed and note-taking have been positively linked in research. Handwriting speed is relevant to all types of writing despite the age of the individual (Peverly et al., 2014). In conclusion, it is evident certain factors can influence a student and his or her ability to take notes. Yet, factors which play a role in the quality of handwritten notes vary when looking at technology based notes. Mueller and Oppenheimer (2014) revealed students who take notes

manually have better retention on factual information only when there was a delay between presentation and test. Therefore, when testing on material immediately after instruction, students' handwritten or typed notes will likely receive similar scores. Typically, classrooms do have a delay between instruction and testing, further implicating the role of handwritten notes for the increased retention of the information.

Technology's Influence on Learning

Minimal research has attempted to determine the link between the importance of handwriting and the use of technology in the 21st century for post-secondary students. The role of handwriting may be changing today since the number of hand-held and compact technological devices, which enable instantaneous feedback, has grown drastically. Teenagers and adults are quickly increasing in their ownership of technology. As of April 2015 within the United States, 92% of adults owned a cell phone, and 73% owned a laptop computer (Pew Research Center, 2015). In a study conducted in Canada, 52.5% of 13-17 year olds and 37.1% of adults 35 and older owned a smartphone (Penhorwood, 2012). Despite the expansion of technology, some students still do not have access to certain technologies such as smartphones or even internet at home due to family circumstances (Penhorwood, 2012).

Popular media such as radio, television, movies and computers are now integrated into the classroom (MacArthur, 2006). Technology has changed the way the classroom is shaped and operated by use of the internet and multimedia, communicating via email and typically requiring assignments to be completed with a word processor instead of with pen and paper (Mogey et al., 2008). However, due to costs, technology is not always accessible and available when needed. Beyond availability, professor beliefs against the integration of technology into the classroom may also persist with the influx of technology (Ertmer, Addison, Lane, Ross, & Woods, 1999).

It has been noted in the classroom, handwriting is used often by students in order to take notes, complete assignments and take tests, especially at a higher grade level (Dennis & Swinth, 2001). The use of technology is beginning to make essay examinations with pen and paper obsolete by using word processors instead. The “Net Generation” has learned to write and spell using word processors and interactive online exercises (Mogey et al., 2008). This conclusion was determined by research performed over ten years ago, is it still true today? Is handwriting used more often in higher education to take notes and test students?

Technology may be eliminating objects from our everyday lives. Phones are capable of more functions than they were ten or even five years ago. Traditional paper and pen exams require instructors to look through erased marks, crossed out lines or words and additional thoughts added in the margins with varying degrees of legible handwriting (Mogey et al., 2008). Immediate feedback takes more time when deciphering pen and paper writing as it demands more time and energy from the professor; legibility may even influence a student’s awarded grade (Mogey et al., 2008; Supon, 2009). Writing by hand provides greater opportunity for students to think outside the box as there are no constraints to putting the pen on paper (MacArthur, 2006). Word processors allow students to edit their work without the threat of stray marks of confusion. Cutting and pasting functions within the word processor allows a smoother flow to change the order of ideas easily or to delete ideas altogether. Students who are proficient at typing may have an opportunity to write more and revise, or change the order of what was first drafted with word processed exams. A word processor allows time for a higher quality piece of writing to be constructed which may change the expectations of teachers when they begin grading. However, a potential downfall is not all students will be proficient or advanced with keyboarding and computer based skills (Mogey et al., 2008).

Young adult students suggest instructors should allot an appropriate amount of time for students to become familiar with the word processor before administering an exam for grading via computer technology in the post-secondary classroom. The biggest concern among young adult students is how individuals with weaker typing skills would be at a disadvantage. The findings were unable to conclude if computer-based essay examinations would yield a higher achievement score by students and if it would then be a more appropriate method to measure performance than a traditional paper exam (Mogey et al., 2008).

The use of laptops in the classroom has shown students are not on task, have decreased performance and are less satisfied than peers with their education (Mueller & Oppenheimer, 2014). Comprehension is impaired when performing multiple tasks, such as attending to a lecture and completing an unrelated online task (Sana, Weston, & Cepeda 2013). Despite the distractions laptops present in the classroom, with internet browsing, games and more, controlling such factors does not necessarily reduce any impairments to a student's note-taking abilities (Mueller & Oppenheimer, 2014). Additionally, individuals within view of peers engaging in multitasking on their laptops suggests the students not using a laptop are at risk for distraction by the decisions of their peers (Sana et al., 2013). The ability to use laptops in class leads to students engaging in more verbatim note-taking, which predicts poorer performance (Mueller & Oppenheimer, 2014). Mueller and Oppenheimer (2014) conducted research with university students comparing pen and paper and laptop note-taking abilities as related to success on exams; this study was the first to show detriments in testing performance due to a student's method of note-taking. If this finding continues to be prevalent among research investigating note-taking methods and exam success, will technology be eliminated from the classroom?

Summary

In summary, there is evidence to support the importance of early education students receive when developing handwriting skills. For students who struggle with the skill of handwriting, early intervention and support in a student's schooling will be beneficial (Cahill, 2009). The understanding and implementation of a mature grasp is essential. The dynamic tripod, although previously set to be the gold standard, is not the only mature grasp. However, handwriting is complicated and influenced by many different factors. For instance, grasp, legibility, and pen design can all impact handwriting development and handwriting performance.

As the classroom environment changes and technology continues to evolve, it is important to determine what purpose handwriting serves today. A systematic method of instruction, supplemental skill development and functional tasks can help a student increase handwriting skills (Cahill, 2009). As this research relates back to occupational therapy, it has been noted students may be more inclined to write for longer periods of time when they have a vested interest or see value in the task at hand rather than worrying about the grade on the assignment (Cahill, 2009).

The lack of extensive research on the continued role of handwriting and developing role of technology in the post-secondary classroom has led to the focus of this current study. This study focused on the relationship between technology and handwriting in the lives of post-secondary university students inside and outside the classroom. The purpose of this current investigation was to explore opinions held by current graduate and undergraduate students about the importance and role of handwriting in the 21st century as technology advances. The series of questions on the survey aimed to determine how students view the curriculum and importance of handwriting education in primary school to understand if current practices are found to benefit a student long term.

Research Questions

With the continuous changes in technology, young adult students are presented with more ways to interact in the classroom and instructional materials have adapted to accommodate the technological growth. These changes present competition between new technology and traditional pen and paper note-taking which is the focus of limited research to date for the young adult post-secondary student population. Possible changes in the role of handwriting for these young adults may have a future impact for the role of handwriting skills and handwriting instruction in primary students. The limited research investigating handwriting versus technology in a young adult post-secondary student population led the primary researcher to expand upon the current field of literature. The primary researcher was seeking to understand preferences and opinions among young adult post-secondary students at East Carolina University in regards to note-taking in the classroom, handwriting for personal use and handwriting instruction at the primary level. The following three research questions were created to be answered by the research process:

1. What are the characteristics of post-secondary students' note-taking methods, specifically handwriting versus technology?
2. How do post-secondary students view handwriting instruction (print and cursive) in primary school curriculums?
3. According to demographical identifiers (i.e. gender) and preferred handwriting grasp, what differences exist among preferred note-taking methods, discomfort/fatigue with handwriting, note-taking method for best retention, and note-taking method for best quality and quantity for post-secondary students?

While answering the aforementioned research questions, several additional questions will be addressed which include the following:

- a. What groups of post-secondary students at East Carolina University prefer handwriting for note-taking over technology?
- b. What is the frequency of handwriting's use for personal tasks among post-secondary students?
- c. What personal tasks are found to have a daily need for handwriting among post-secondary students?
- d. What note-taking method do post-secondary students find to be most effective in quality and quantity of note-taking in the post-secondary classroom?
- e. What is the amount of time note-taking methods are used among post-secondary students in the classroom?
- f. What differences exist between groups of post-secondary students at East Carolina University in regards to handwriting and technology for the personal and classroom setting?
- g. What technology is used most often by post-secondary students?
- h. How often are post-secondary students using technology throughout their day, for personal or educational use?

The additional questions were implemented into the survey created for the research process.

The responses enabled the researcher to continue to investigate the role of handwriting versus technology in the classroom with regards to note-taking specifically as well as personal uses for handwriting. The research also explored the opinions young adult students hold concerning the role and benefit of handwriting instruction for primary students in the classroom. Taking into account the research questions and subset of additional questions, the primary researcher created a survey to identify the current level of engagement college students have with handwriting and

technology in the classroom, identify what tasks outside the classroom require handwriting and how often tasks are performed, and the college students' perceptions of the role of handwriting instruction for both cursive and print for primary-aged students.

CHAPTER 3: METHODOLOGY

Design

The study conducted was a non-experimental design to address the research questions because the aim was to determine what is naturally occurring with young adults handwritten note-taking in the classroom despite continued technological advancements. The instrument of choice for the study was a survey designed specifically for use in this study. An online survey was used for increased ease of access for the target population to gather demographical data, factual information, and opinions from post-secondary students.

The sample of students was randomly selected from all students registered for classes at East Carolina University. The study received approval from the University and Medical Center Institutional Review Board at East Carolina University and East Carolina University's Survey Review and Oversight Committee in order to administer the survey to current students for data collection.

Participants

The participants were a sample of students chosen at random from the East Carolina University student body who were 18 years and older. Both undergraduate and graduate level, full-time and part-time students were included in the randomized selection process. Exclusion criteria for participants included participants over 30 years of age (in order to maintain a young adult student population) and those who did not use a technological device (smartphone, tablet, or laptop due to limited exposure to and role technology would play in everyday life). Recruitment consisted of gathering a random sample of 1800 email addresses from the Survey Review and Oversight Committee. From the sample, 146 students participated in the survey but 39 student responses were eliminated due to exclusion criteria (greater than 30 years of age). No

participants were eliminated due to not regularly using a technological device. Therefore, the sample size analyzed for this study was 106 (N=106).

Participant names and email addresses were provided by the Survey Review and Oversight Committee but the primary researcher deleted student names and only entered email addresses into a Qualtrics email distribution list. Participants were provided background on the aim of the study as well as how the results would be analyzed and interpreted within the email that was distributed to them with the survey link. The first question within the survey asked post-secondary students to consent to participate, informed participants no personal identification would be linked to responses, and informed the participant that he/she could end the survey at any time. In combination with the consent notification, students were asked to agree or disagree in order to participate or decline participation in the survey.

Instrument

The instrument for this study was a survey specifically developed to collect demographical data, preferred note-taking methods, percentage of time using note-taking methods, technology used, how long technology is used, opinions of handwriting for personal and classroom use and opinions of print and cursive handwriting instruction (see Appendix A). The final survey was administered through Qualtrics, an online survey system, for ease of access. Qualtrics allowed the progress of the survey to be displayed at the bottom of the page to inform the participant how much of the survey remained. This feature was included to entice individuals to complete the survey in its entirety once begun by providing feedback on the amount remaining and thus estimated time commitment. In addition, questions were organized and labeled by topic to increase the user friendliness of the survey. The labeled topics included handwriting mechanics, handwriting and injuries, handwriting, technology, post-secondary, and

demographical information. Furthermore, the survey included questions about the uses of handwriting, note-taking methods, and past hand or wrist injuries. The short sections created more pages to the survey, and prevented students from being overwhelmed by the length of one page for all questions. The sections made each page more manageable and mobile friendly if a student opted to take the survey on a device with a smaller screen such as a smartphone or tablet. More generalized questions investigated the relevance of handwriting and usage of technological devices, preferred method used for effective and efficient note-taking and the role of technology in the classroom.

The types of questions used in the survey included use of a 5 point Likert scale, yes/no, open-ended and demographic questions. There was an additional question asking students to best identify their handwriting grasp based on pictures provided. Within the survey, Likert scale questions were included to gather information on the opinions of different aspects of handwriting and the use of handwriting or technology. The questions used a five-point scale as follows: (1) strongly disagree; (2) disagree; (3) neutral; (4) agree; (5) strongly agree. The questions investigated legibility, the necessity of handwriting in the 21st century, and retention of written material. The open-ended questions required some degree of typed response from the student. These questions inquired about the role of handwriting in daily life and in the classroom, and the role of instruction for both print and cursive handwriting. The demographic portion of the survey asked questions regarding the individual's education, gender, age, technology devices, handedness and other traits, some demographic questions were optional. A scanned copy of the Qualtrics survey has been included in Appendix A. The final survey included 11 conditional questions that participants only completed if they answered a prior question a certain way; 4 related to hand and wrist injuries, 3 regarding the percentage of time using different note-taking

methods, and 4 investigating the hours spent using technology devices. All questions required the participant to answer before moving on except for the role of handwriting in everyday life, identification of race, GPA and the number of credits a student was registered for in the current semester. The consent statement for students can be found in Appendix B and the email message to students can be found in Appendix C. These statements were included to inform students what the information collected would be used for as well as the purpose and objective of the survey and research.

Procedure

Pilot Study and Expert Review. A pilot study was conducted in order to strengthen the validity and reliability of the survey questions to ensure the intended data was being collected. A sample of graduate students was used for the pilot study based on convenience and volunteering. The primary researcher recruited pilot students from the Master of Science in Occupational Therapy department through email, posts on a group social media page and word of mouth. The pilot study consisted of 8 graduate level students, 7 of which were also interviewed to gain further knowledge about the quality of the survey. The students provided their email address to the primary researcher who emailed the appropriate survey link to the individuals. The students were randomly assigned to participate in one of two pilot versions of the survey: (1) the survey that included all of the questions, whether the participant met the condition to reveal the conditional questions or not or (2) the survey that did not include all conditional questions, but flowed as it would for a regular participant. When students were emailed the survey link, 4 took the survey as would be presented to the research participants in addition to some comment questions. The other 4 students were sent the survey with all questions displayed including comment questions, and they did not have to answer the survey questions unless they desired to

do so. Pilot study students were given two weeks to complete the survey and schedule a meeting with the primary researcher to discuss the survey. The researcher sent a reminder email after one week to make sure all pilot students took the survey and scheduled a meeting time. After students took the pilot study, 7 of the 8 students met individually for a brief 15-minute discussion with the primary researcher to review the format of the survey and any suggested modifications for usability. These two survey administrations would also be used to determine an approximate amount of time that would be required to complete the survey. This would allow the email to the random sample of students to include an accurate estimate of the time commitment to complete the survey. The pilot study was also conducted in two different manners to receive feedback on all questions since some students would not see some of the conditional questions based on their responses. The decision to use both written and verbal feedback, through comment questions and discussion, was done to eliminate misinterpretation of the comments to lead to more effective and appropriate survey changes.

While the pilot study was administered to pilot students, the same survey was administered to individuals for an expert review. The research advisor, Dr. Denise Donica, solicited feedback from certified Handwriting Without Tears® experts, with extensive handwriting knowledge and varying clinical experience, to review the wording and content of the survey. All experts volunteered and responded to a version of the survey that included all possible questions (no conditional requirements were placed on the questions). This handwriting expert panel answered the same comment questions as the pilot students to provide suggestions to minimize bias and eliminate leading words in questions. The expert panel reviewers were given two weeks to complete the pilot study, the same amount of time given to pilot students. The expert panel reviewers received a reminder email after one week passed to encourage a

higher response rate. There were 4 experts who chose to participate in the expert review from a list of 7 individuals who originally agreed to participate.

The pilot study, used for students and expert reviewers, included comment questions designed to reference a specific question or subset of questions. Comment questions were anticipated to encourage organized feedback in critiquing the survey. The email message accompanying the pilot study and expert review explained there would be certain questions requiring an answer, comment questions only for non-conditional survey takers or comment questions and survey questions for conditional survey takers. Students and expert reviewers were informed all responses would be anonymous and their responses would not be used in the final data collection results.

After the pilot study was administered, results were reviewed and grouped based on the question(s) for which comments were provided. Advice and tips to strengthen the wording of questions and overall structure were taken into account by the primary researcher. Comments for each question were organized based on the topic discussed, such as whether there might have been bias in the question or general confusion in the wording. The primary researcher determined if recommendations were valid changes based on a degree of similarity in feedback, changes were made or not made to the discretion of the primary researcher to encourage validation of the survey questions. Changes made after the pilot study and expert review process included formatting of questions for ease of use, changing wording or adding more to clarify the directions for each question to gather the desired response, and adjusting the order and total number of questions. After comments and concerns were thoroughly reviewed and changes were made, the survey was ready for submission to the East Carolina University Medical Center

Institutional Review Board committee to approve the survey for administration through Qualtrics for the study.

Research Study. To achieve the goal of a minimum of 180 participants, 1800 email addresses were solicited from the East Carolina University Survey Review and Oversight Committee. The primary researcher anticipated a 10% response rate based on the number of email addresses solicited to participate. A larger response rate would provide more support for the findings from the data collected. On the first day the survey opened, the primary investigator emailed all selected students the message included in Appendix B along with the survey link. At the beginning of weeks 3, 4 and 5 the entire sample of students received an automated email reminder. The students were given 5 weeks in total to complete the survey. This timeline was selected in order to accommodate the primary researcher in her graduate program schedule. The survey opened Monday March 16, 2015 and closed Sunday April 19, 2015. The survey link was sent from the primary researcher's student email address and any questions about the survey were directed toward a third party email address created specifically for this study (HWSurveyECU@gmail.com) by the primary researcher.

Data Analysis

At the completion of the survey, all data was collected and organized into formatted tables as seen in Chapter 4. The results were organized and analyzed based on overall responses and two age groups of a young adult population, traditional (18-22 years-old) and non-traditional (23-30 years-old) students.

Preferred note-taking methods were used to determine the common note-taking methods among participants. Results were calculated based on traditional and non-traditional students. The percentage of time spent using each note-taking method in the classroom environment,

preferred technology devices and time spent using the device each day was also determined. Furthermore, the data reported how East Carolina University students utilize handwriting for personal tasks, including how often personal tasks require handwriting.

Responses were assessed to determine the value post-secondary students place on handwriting instruction at the primary level for both print and cursive writing. Student responses were coded to establish common opinions among post-secondary students for the open-ended questions. To interpret the findings in an organized fashion, the primary researcher generalized responses based on common topics and thoughts discussed. Coding was not exclusive, depending on the response provided it may have received more than one code, no response was assigned more than four codes. As such, the corresponding percentages for the coding are not out of the total number of responses but the total number of codes for each question, which may have exceeded the number of participants. Additionally, if there were responses which were unable to be categorized, it was coded as “other.” Examples of uncategorized responses include, stated above, a numeric scale, not applicable or unsure.

Student engagement with note-taking methods was analyzed using chi square analysis to determine if differences exist among groups of students. Analysis was conducted to determine if different groups of students prefer a particular note-taking method, the method for best retention, method for best quality and method for best quantity of notes based on participant perception. Groups compared included those using immature or mature handwriting grasps and males or females. Student self-identified handwriting grasps were categorized as mature or immature based on the literature. Mature grasps included the dynamic tripod, dynamic quadrupod, lateral tripod, and lateral quadrupod. The immature grasps included four finger, interdigital, other and those who selected more than one grasp if at least one selected was four finger, interdigital or

other. Likert scale responses such as “I retain information more accurately and thoroughly when I write it down” were condensed to agreement, neutral or disagreement. Responses for methods of note-taking responsible for enabling the most accurate and on topic or greater quantity of notes was condensed to pen and paper versus technology. These responses were condensed to allow more accuracy with the chi square analysis.

Once all data was organized accordingly, inferences were made based on the data and patterns revealed. Conclusions were formulated and final thoughts and remarks can be found in Chapter 5.

CHAPTER 4: RESULTS

Demographics

Table 1 summarizes the demographic information pertaining to the survey participants. From the 106 responses, the young adult participants were categorized into two age groups. Group 1 includes participants ages 18-22, to signify the traditional post-secondary undergraduate if a student left a secondary institution and immediately began at a four-year university. Group 2 includes participants ages 23-30 who are non-traditional students.

Table 1. Demographic Data

Descriptor	Group 1 n=71 (age ≤ 22) n (%)	Group 2 n=35 (23 ≤ age ≤ 30) n (%)	Total N=106 N (%)
Gender			
<i>Female:</i>	58 (81.7)	27 (77.1)	85 (80.2)
<i>Male:</i>	13 (18.3)	8 (22.9)	21 (19.8)
Enrollment Status			
<i>Full Time:</i>	68 (95.8)	28 (80.0)	96 (90.6)
<i>Part Time:</i>	3 (4.2)	7 (20.0)	10 (9.4)
<i>Other:</i>	0 (0)	0 (0)	0 (0)
Handedness			
<i>Right:</i>	64 (90.1)	30 (85.7)	94 (88.7)
<i>Left:</i>	2 (2.8)	3 (8.6)	5 (4.7)
<i>Ambidextrous:</i>	5 (7.1)	2 (5.7)	7 (6.6)
Year of Study			
<i>Undergraduate Freshman:</i>	18 (25.3)	0 (0)	18 (17.0)
<i>Undergraduate Sophomore:</i>	20 (28.2)	3 (8.6)	23 (21.7)
<i>Undergraduate Junior:</i>	13 (18.3)	2 (5.7)	15 (14.2)
<i>Undergraduate Senior:</i>	19 (26.8)	11 (31.4)	30 (28.3)
<i>Graduate Students:</i>	1(1.4)	15 (42.9)	16 (15.1)
<i>Certificate:</i>	0 (0)	0 (0)	0 (0)
<i>Non Degree Seeking:</i>	0 (0)	1 (2.9)	1 (0.9)
<i>Other:</i>	0 (0)	3 (8.6)	3 (2.8)

Based on the responses of young adults, most respondents were full-time undergraduate right handed female students who preferred writing in a blended style and were between the age of 18 and 22 years-old.

Post-Secondary Students’ Note-Taking Methods

Table 2 shows based on the total number of young adult respondents (N=106), the number of students regularly using each method to take notes. Students were allowed to select more than one method if applicable for their note-taking methods in the classroom and then recorded what percentage of their note-taking time was spent with each method they selected.

Table 2. Note-Taking Methods and Percentage of Time Using Each Method

Note-Taking Method	Number of Total Responses (N)(%)	Number of Responses for Interval (n)(%)
<i>Handwriting</i> 0% - 24% 25% - 49% 50% - 74% 75% - 100%	99 (93.3)	4 (4.0) 6 (6.0) 17 (17.2) 72 (72.7)
<i>Computer/Typing</i> 0% - 24% 25% - 49% 50% - 74% 75% - 100%	50 (47.2)	24 (48.0) 9 (18.0) 10 (20.0) 7 (14.0)
<i>Audio Recordings</i> 0% - 24% 25% - 49% 50% - 74% 75% - 100%	13 (12.3)	3 (23.1) 6 (46.2) 3 (23.1) 1 (7.7)
<i>Other</i>	2 (1.9)	

Amount of Time Using Each Note-Taking Method. As identified in Table 2, handwriting is used 75-100% of the time in the classroom by 72 (72.7%) of the participants, while computer/typing notes is used 0-24% of the time by 24 (48.0%) of the participants using this note-taking method.

Table 3 represents categorized responses based on similar ideas and concepts students have in regards to the viewpoint of handwriting's importance within the classroom.

Table 3. Handwriting Importance in the Classroom

Question: What importance do you think handwriting has in the CLASSROOM during this current expansion in technology?	N (%)*
Handwriting helps you better retain information, remember and it builds a foundation of skills	49 (46)
Important	29 (27)
Less important or not needed	11 (10)
Less distraction then technology, helps students stay focused	11 (10)
More accessible, less cost, no chance of malfunction	8 (8)
Aids in learning, helps learn note-taking strategies, provides foundational knowledge that can lead to reading, etc.	8 (8)
Students have different preferences of note-taking, some prefer the speed and flexibility	6 (6)
Exams, notes, math still need to be handwritten	6 (6)
Freedom to format, freedom to express	4 (4)
Other	4 (4)
Technology should be used more than handwriting	1 (1)

*Responses may have been assigned more than one code

Technology in Secondary and Post-Secondary Education. Table 4 reports how often students perceived they were allowed to use technology for note-taking in post-secondary classrooms. Students also reported if technology was allowed for secondary education note-taking, only 22 (21%) students reported technology was allowed while 84 (79%) were not allowed to use technology.

Table 4. Frequency of Technology as an Option for Note-Taking in the Post-Secondary Classroom

Frequency of Option to Take Notes Through Technology	N (%)
Never	2 (2)
Rarely	2 (2)
Sometimes	25 (24)
Often	46 (43)

All of the time	31 (29)
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Differences Between Groups of Post-Secondary Students. Table 5 differentiates data collected from traditional (group 1) and non-traditional (group 2) students who participated in the survey. It presents responses for multiple choice and Likert scale questions pertaining to note-taking, handwriting and technology in general.

Table 5. Comparison of Characteristics of Traditional and Non-Traditional Students

Question	Group 1 (age ≤ 22) N (%)	Group 2 (23 ≤ age ≤ 30) N (%)	Total N (%)
How often discomfort/fatigue occurs with handwriting			
<i>Not at all:</i>	22 (31.0)	11 (31.4)	33 (31.1)
<i>Occasionally:</i>	47 (66.2)	20 (57.1)	67 (63.2)
<i>Frequently:</i>	2 (2.8)	4 (11.4)	6 (5.7)
Preferred Note-taking Methods			
<i>Handwriting:</i>	66 (93.0)	33 (94.3)	99 (93.4)
<i>Computer/Typing:</i>	36 (50.7)	14 (40.0)	50 (47.2)
<i>Audio Recordings:</i>	7 (9.9)	6 (17.1)	13 (12.3)
<i>Other:</i>	1 (1.4)	1 (2.9)	2 (1.9)
Belief that handwriting is no longer necessary			
<i>Strongly Disagree:</i>	46 (64.8)	25 (71.4)	71 (67.0)
<i>Disagree:</i>	17 (23.9)	9 (25.7)	26 (24.5)
<i>Neutral:</i>	5 (7.0)	1 (2.9)	6 (5.7)
<i>Agree:</i>	2 (2.8)	0 (0)	2 (1.9)
<i>Strongly Agree:</i>	1 (1.4)	0 (0)	1 (0.9)
Belief they retain information more accurately when writing it down			
<i>Strongly Agree:</i>	40 (56.3)	23 (65.7)	63 (59.4)
<i>Agree:</i>	22 (31.0)	7 (20.0)	29 (27.3)
<i>Neutral:</i>	6 (8.5)	3 (8.6)	9 (8.5)
<i>Disagree:</i>	1 (1.4)	0 (0)	1 (0.9)
<i>Strongly Disagree:</i>	2 (2.8)	2 (5.7)	4 (3.8)
Technological Devices Used			
<i>Tablet/iPad:</i>	31 (43.7)	17 (48.6)	48 (45.3)
<i>Laptop:</i>	68 (95.8)	33 (94.3)	101 (95.3)
<i>Desktop Computer:</i>	19 (26.8)	9 (25.7)	28 (26.4)
<i>Smartphone:</i>	68 (95.8)	32 (91.4)	100 (94.3)
Belief that note-taking is more accurate with			
<i>Tablet:</i>	1 (1.4)	0 (0)	1 (0.9)

<i>Laptop:</i>	15 (21.1)	6 (17.1)	21 (19.8)
<i>Smartphone:</i>	0 (0)	0 (0)	0 (0)
<i>Pen and paper, handwriting:</i>	55 (77.5)	29 (82.9)	84 (79.2)
<i>Other:</i>	0 (0)	0 (0)	0 (0)
Belief that more notes can be recorded with			
<i>Tablet:</i>	1 (1.4)	0 (0)	1 (0.9)
<i>Laptop:</i>	27 (38.0)	9 (25.7)	36 (34.0)
<i>Smartphone:</i>	0 (0)	1 (2.9)	1 (0.9)
<i>Pen and paper, handwriting:</i>	42 (59.2)	25 (71.4)	67 (63.2)
<i>Other:</i>	1 (1.4)	0 (0)	1 (0.9)

Table 6 and Table 7 show student self-reported grasps and writing style per traditional and non-traditional participants.

Table 6. Preferred Writing Grasp

Grasp*	Group 1 (age ≤ 22) n (%)	Group 2 (23 ≤ age ≤ 30) n (%)	Total N (%)
Mature Grasps			
Figure 1- Dynamic Tripod	20 (28.2)	20 (57.1)	40 (37.7)
Figure 2- Dynamic Quadrapod	30 (42.3)	7 (20.0)	37 (34.9)
Figure 3- Lateral Tripod	12 (16.9)	5 (14.3)	17 (16.0)
Figure 4- Lateral Quadrapod	14 (19.7)	2 (5.7)	16 (15.1)
Immature Grasps			
Figure 5- Four Finger	5 (7.0)	1 (2.9)	6 (5.7)
Figure 6- Interdigital	1 (1.4)	1 (2.9)	2 (1.9)
Not Displayed	3 (4.2)	2 (5.7)	5 (4.7)

*Participants may have selected more than one grasp if applicable

Table 7. Preferred Writing Style

	Group 1 (age ≤ 22) n (%)	Group 2 (23 ≤ age ≤ 30) n (%)	Total N (%)
Print	36 (50.7)	8 (22.9)	44 (41.5)
Cursive	6 (8.5)	2 (5.7)	8 (7.5)
Blended	29 (40.8)	25 (71.4)	54 (50.9)
Other	0 (0)	0 (0)	0 (0)

Frequency of Handwriting Needed for Preferred Personal Tasks. Participants reported personal tasks which required handwriting and how frequently they used handwriting to

complete each task. Table 8 presents the different personal tasks based on the frequency of times they complete the task using handwriting along with the number of participants and percentage of responses for each handwriting task. For each handwriting activity, the frequency of time selected by the greatest number of participants has been highlighted.

Table 8. Handwriting Use in Daily Life for Personal Tasks

Handwriting Activity	Frequency N(%)						
	Daily	2-3x Week	Once a Week	2-3x Month	Once a Month	Less than Once a Month	Never/Not Applicable
To Do Lists, Shopping Lists, etc.	23 (22)	22 (21)	27 (26)	17 (16)	7 (7)	9 (9)	0 (0)
Exams/Quizzes	4 (4)	14 (13)	18 (17)	39 (37)	12 (11)	11 (10)	7 (7)
Notecards for learning, textbook notes	14 (13)	33 (31)	16 (15)	20 (19)	6 (6)	10 (10)	6 (6)
Travel Directions	0 (0)	0 (0)	3 (3)	8 (8)	16 (15)	46 (44)	31 (30)
Meeting Notes	4 (4)	10 (10)	20 (20)	19 (19)	20 (20)	16 (16)	13 (13)
Post It Notes/Reminders	34 (32)	27 (26)	16 (15)	15 (14)	5 (5)	5 (5)	3 (3)
Signing Documents	11 (11)	21 (20)	10 (10)	32 (31)	16 (15)	14 (13)	0 (0)
Taking Notes – in general	66 (62)	26 (25)	7 (7)	3 (3)	3 (3)	1 (0)	0 (0)
Journal/Devotional	7 (7)	9 (9)	11 (10)	10 (10)	10 (10)	35 (33)	23 (22)
Recipes	1 (0)	7 (7)	4 (4)	15 (15)	15 (15)	44 (43)	17 (17)
Grading Papers/Peer Reviewing	1 (0)	6 (5)	4 (4)	9 (9)	15 (14)	45 (43)	25 (24)
Task Instructions	10 (10)	20 (19)	15 (14)	15 (14)	17 (16)	17 (16)	10 (10)
Marking Photos – names & dates	1 (0)	0 (0)	0 (0)	5 (5)	8 (8)	56 (54)	33 (32)
Planner/Calendar/Daily Schedule	48 (46)	21 (20)	13 (13)	6 (6)	2 (2)	11 (11)	3 (3)
Whiteboard/Dry Erase Board	12 (11)	13 (12)	13 (12)	12 (11)	9 (9)	29 (28)	17 (16)
Job Applications	0 (0)	0 (0)	1 (0)	7 (7)	10 (10)	67 (64)	19 (18)
Notes (Thank You, Encouragement, General)	3 (3)	3 (3)	4 (4)	19 (18)	22 (21)	43 (42)	9 (9)
Messages from Voicemail	6 (6)	3 (3)	1 (0)	2 (2)	10 (10)	40 (38)	42 (40)
Medical Forms	0 (0)	0 (0)	0 (0)	10 (10)	25 (24)	62 (60)	7 (7)
Forms (School, Sports, Tax, etc.)	4 (4)	7 (7)	12 (11)	19 (18)	22 (21)	38 (36)	3 (3)
Birthday Cards/Greeting Cards	0 (0)	0 (0)	0 (0)	10 (10)	28 (27)	61 (58)	6 (6)
Data Collection for Work	19 (19)	8 (8)	11 (11)	9 (9)	4 (4)	22 (22)	29 (28)
Labeling Personal Items – clothing, casserole dish, etc.	1 (0)	3 (3)	6 (6)	11 (11)	14 (13)	45 (43)	24 (23)
Writing Letters/Addressing Envelopes	1 (0)	4 (4)	7 (7)	19 (18)	23 (22)	41 (39)	10 (10)
Writing and Signing Checks, Signing Credit Card Receipts	14 (13)	27 (25)	13 (12)	26 (25)	13 (12)	10 (9)	3 (3)

Given the opportunity to list additional uses for handwriting, participants identified creative writing outlets (song lyrics, etc.), calligraphy/doodling/arts in general, specific work/volunteer tasks, parent related obligations to communicate with others, and math problems.

Using Handwriting Daily for Personal Tasks. Based on the data in Table 8, post-secondary students reported using handwriting daily for three activities: post-it notes/reminders, taking notes in general and a planner/calendar/daily schedule. Table 9 presents codes assigned to post-secondary student opinions of handwriting for everyday life.

Table 9. Handwriting Importance in Everyday Life

Question: What importance do you think handwriting has in EVERYDAY LIFE during this current expansion in technology?	N (%)*
Important	31 (29)
More likely to remember information written down, requires more thought and concentration	20 (19)
More personal	19 (18)
Not important, less important or less necessary	16 (15)
Form of communication and expression	13 (12)
More readily accessible, no chance of malfunction	13 (12)
Used for bills, signing receipts, documents, forms, etc.	11 (10)
Quick, no distractions, cheaper to write than to type and print (ink cartridges), more convenient/very portable	9 (8)
Used for simple things, basic tasks, quick notes	8 (8)
More relevant than we realize	6 (6)
Dependent on your occupation	4 (4)
Other	3 (3)
Not relevant for everyone	2 (2)
The paperless era is here	1 (1)

*Responses may have been assigned more than one code

Note-Taking Method for the Best Accuracy and Amount of Notes. Participants reported pen and paper handwritten notes were the most common method for accurate and on-topic information, 84 (79%) participants agreed. Laptop notes were the second most common accurate method chosen by 21 (20%) participants. A tablet was selected by 1 (1%) participant.

Participants identified the method of note-taking found to enable more information to be recorded in a given class period. Sixty-seven (63%) participants found pen and paper handwriting to lead to a greater amount of information being recorded; laptops were the second method chosen by 36 (34%) participants. A tablet, smartphone or other was selected by 1 (1%) participant.

Technology Used by Post-Secondary Students. Table 10 reports the number of participants using each technology device in general and subsequently the amount of time spent using the device each day, for any type of use.

Table 10. Technology Used & Amount of Time Spent Using Technology Daily

Technology Used & Amount of Time Using Technology Daily	Number of Participants Who Use Each Device (N)(%)	Number of Responses for Each Interval (n)(%)
Tablet/iPad <i>0-2 hours</i> <i>3-4 hours</i> <i>5-6 hours</i> <i>7-8 hours</i> <i>9+ hours</i>	48 (45)	33 (69) 13 (27) 2 (4) 0 (0) 0 (0)
Laptop <i>0-2 hours</i> <i>3-4 hours</i> <i>5-6 hours</i> <i>7-8 hours</i> <i>9+ hours</i>	101 (95)	25 (25) 42 (42) 17 (17) 11 (11) 6 (6)
Desktop Computer <i>0-2 hours</i> <i>3-4 hours</i> <i>5-6 hours</i> <i>7-8 hours</i> <i>9+ hours</i>	28 (26)	12 (43) 10 (36) 1 (4) 3 (11) 2 (7)
Smartphone <i>0-2 hours</i> <i>3-4 hours</i> <i>5-6 hours</i> <i>7-8 hours</i> <i>9+ hours</i>	100 (94)	18 (18) 22 (22) 25 (25) 16 (16) 19 (19)

*Participants may have selected more than one device if applicable

Post-Secondary Student Opinions of Handwriting Instruction at the Primary Level

When asked if print education is still important at the primary level, 104 (98.1%) participants agreed and 2 (1.9%) disagreed. Conversely, 73 (68.9%) students agreed and 33 (31.1%) disagreed cursive handwriting education is still important at the primary level.

Role and Benefit of Handwriting Education for Young Learners. Tables 11-12 report the codes assigned to post-secondary responses in relation to the importance of print and cursive education at the primary school level.

Table 11. Print Instruction in Primary Curriculums

Question: Do you think the education for print handwriting is still an important component that should remain in the elementary grade level curriculum?	N (%)*
Handwriting aids in learning, reading, it's a basic skill, makes one literate, aids with fine motor development	37 (40)
Written form of communication, still needed, professional skill, useful	26 (28)
Important	24 (26)
Accessible, low cost	10 (11)
Computers can't do everything, not everything can be done on computers	7 (8)
Logical, when else would handwriting be taught, needs to be learned	6 (7)
Used for documents, identification	2 (2)
Limiting if you don't know how to write	1 (1)
Not important	1 (1)
Preference of the student if it is important	1 (1)

*Responses may have been assigned more than one code

Table 12. Cursive Instruction in Primary Curriculums

Question: Do you think cursive education is still an important component that should remain in the elementary grade level curriculum?	N (%)*
Used for documents, signatures, receipts	38 (43)
Not as important, not as relevant, not used as often	20 (22)
Easy, quick, speedy, more fluid, more creative than print	12 (13)
Important, important to an extent	9 (10)
Essential skill, good to know how to read and write cursive	9 (10)
More formal than print	6 (7)

Provides an identity	4 (4)
Aids with fine motor development, helps with memory and learning	2 (2)
Other	1 (1)

*Responses may have been assigned more than one code

Analysis of Relationships Related to Student Note-Taking

A series of chi-square tests were performed and no relationships were found between any two variables. Mature and immature grasp patterns and preferred note-taking method (handwriting, computer/typing, audio recordings, or other) showed no relationship, $X^2 (2, N = 106) = 1.19, p = 0.55$. Grasp patterns and the degree of discomfort/fatigue (not at all, occasionally or frequently) experienced with school-related tasks by participants showed no relationship, $X^2 (2, N = 106) = 1.30, p = 0.52$. Mature and immature grasp patterns and participant beliefs (strongly agree/agree, neutral, or disagree/strongly disagree) for the better retention with handwritten notes showed no relationship, $X^2 (2, N = 106) = .42, p = 0.81$. Mature and immature grasp patterns and participant beliefs for the note-taking method (tablet, laptop, smartphone, pen and paper/handwriting, or other) for best accuracy showed no relationship, $X^2 (1, N = 106) = 1.30, p = 0.25$. Mature and immature grasp patterns and the belief for the note-taking method (tablet, laptop, smartphone, pen and paper/handwriting, or other) for best quantity showed no relationship, $X^2 (1, N = 106) = 2.98, p = 0.09$.

Gender and preferred note-taking method showed no relationship, $X^2 (2, N = 106) = .52, p = 0.77$. Gender and discomfort/fatigue experienced with school-related tasks by participants showed no relationship, $X^2 (2, N = 106) = 0.09, p = 0.96$. Gender and participant beliefs for better retention with handwritten notes showed no relationship, $X^2 (2, N = 106) = 0.15, p = 0.93$. Gender and participant beliefs for the note-taking method for best accuracy showed no relationship, $X^2 (1, N = 106) = 0.15, p = 0.70$. Gender and participant beliefs for the note-taking method for best quantity showed no relationship, $X^2 (1, N = 106) = 0.56, p = 0.46$.

From the series of chi square testing, no relationships were found between handwriting grasps or gender with reference to preferred note-taking methods, discomfort/fatigue experienced with school-related tasks, the belief notes are best retained through handwriting, the belief of the note-taking methods for best accuracy and the belief for the note-taking method allowing the greatest quantity of recorded notes.

Due to the limited number of participants (N=106), when chi square analysis was performed responses were further condensed and categorized to limit the number of low cell counts. If a chi square analysis was performed with each individual grasp pattern and each method of note-taking the 7x4 grid was too large and resulted in too many low cell counts to produce accurate analysis. Therefore, handwriting grasp patterns (mature and immature), note-taking methods (handwriting, technology or handwriting and technology), opinions of retention (strongly agree/agree, neutral, disagree/strongly disagree), note-taking methods (pen and paper/handwriting or technology) for best accuracy and note-taking methods (pen and paper/handwriting or technology) for the most notes were further combined. For instance, combining similar responses based on technology versus individual pieces of technology limited the grid size for the chi square analysis; the grid sizes were either 2x3 or 2x2.

If more students had decided to participate it would may have been possible to leave each response option within the chi square analysis to further analyze the data in more detail. Future research can investigate similar ideas with a larger pool of participants to identify how the participant size may have impacted the opportunity to view relationships between handwriting grasp or gender with preferred note-taking methods, opinions of retention with handwriting, note-taking methods for best accuracy and note-taking methods that yield the greatest amount of information to be recorded.

CHAPTER 5: DISCUSSION

The demographic data as compared to the total student body at East Carolina University revealed differences in the participant pool. Participants were made up of 91% full-time and 9% part-time students while the overall student population was 78% full-time and 22% part-time (Office of Institutional Planning, Assessment, and Research, 2014). In the survey 20% were male and 80% were female responses and the university has a distribution of 40% males and 60% females (Office of Institutional Planning, Assessment, and Research, 2014). Student enrollment status and gender differences between survey participants and the student population was greater than anticipated, potentially interfering with the ability to extrapolate results to represent the entire student body at East Carolina University.

Additional statistics reported by the Office of Institutional Planning, Assessment and Research (2014) about the East Carolina University student body as of the fall 2014 semester present ideas for questions which could have been helpful to ask participants for further enrollment details. If students enrolled in more online courses, would a note-taking preference be predetermined as most of the interaction in the “classroom” for learning would occur on the computer, laptop or desktop? Is there a relationship between course environment (classroom versus online) and preferred note-taking methods? Nearly 40% of students were enrolled in at least one online course (Office of Institutional Planning, Assessment, and Research, 2014). For non-traditional students who may go back to school to change careers but have a family, work or other personal obligations to uphold as well, online courses may be the preferred setting for learning due to ease of access and flexibility in the schedule. Furthermore, if online courses become the pattern, will it increase the tendency for students to engage with technology when taking notes?

The traditional and non-traditional post-secondary student groups revealed similar findings. All but one student in the 18-22-year-old group was an undergraduate student; more fluctuation was found among 23-30 year-old students with undergraduate seniors dominating the group. This finding may not be equal across campuses or regions of the country, another concept to keep in mind if proceeding with continued future research.

Characteristics of Post-Secondary Students' Note-Taking Methods

From the data collected, it was determined young adult post-secondary participants still engaged in handwriting for educational note-taking. Participants of both genders, all handwriting grasps (mature and immature), student status (enrollment status), and degree level (year of study) reported engagement with handwriting for note-taking purposes. Nearly all participants (93%) used handwriting for note-taking in the classroom while 47% of participants used a computer/typing. Furthermore, 72 (72.7%) of participants reported using handwriting for 75-100% of their note-taking experiences. As technology advances, post-secondary participants still preferred handwriting over technology options when taking notes in the classroom, it appears that students still find value in traditional pen and paper note-taking over other methods. Prior research indicates post-secondary students using laptops did not fully understand course material and experienced decreased course performance (Fried, 2008). This finding supports the benefit of post-secondary participant preferences for handwritten note-taking as it will provide greater support for academic success. If students do not engage in laptop use in the classroom, the risk of engaging in activities other than note-taking will decrease and students will not need to share cognitive resources to multitask (Fried, 2008; Sana et al., 2013). Group 1 and group 2 reported strong disagreement that handwriting is no longer necessary in the 21st century, 46 (64.8%) and 25 (71.4%) students accordingly. Furthermore, 66 (93.0%) and 33 (94.3%)

participants of group 1 and group 2 participants reported use of handwritten notes in the classroom while only 36 (50.7%) and 14 (40.0%) accordingly used computers to type notes.

Furthermore, when asked to identify handwriting's role in the post-secondary classroom, 46% of participants mentioned the positive attribute of increased retention of information when handwriting notes within their open ended responses. Participants also identified finding themselves better able to retain information when writing it down when given the choice. As proved through research, handwriting aids with sustained attention and memory awareness which supports the belief of participants that handwriting enables better retention (Feder & Majnemer, 2007). Handwriting was reported to help students remember the information and build the foundation of learning skills within the classroom environment. Eleven (10%) participants reported handwriting is less important or not needed and only 1 (1%) believed technology should be used more than handwriting based on open-ended responses. Eleven (10%) participants also stated handwriting provides less distraction and helps students stay focused due to limiting the potential for multitasking.

It is possible that the preferred method of note-taking may be influenced by classroom policies that may limit computer use. Since faculty member perceptions were not included in this study, it is unknown how faculty opinions of classroom-based note-taking may impact student engagement due to rules and regulations set forth. Research has reported that many professors continue to wonder if technology will positively impact education (Fried, 2008). Participants reported how often they perceived faculty members allowed technology in the post-secondary classroom. The reporting system for technology usage allowed in the classroom was not specific and personal interpretation may have influenced how participants perceived the categories of never, rarely, sometimes, often or all of the time which affected accuracy of responses. From the

responses, 43% were allowed to use technology often while another 29% were allowed to use technology all of the time. Future research can include professor reports on technology policies for the classroom.

In addition to post-secondary classroom technology-use policies, participants may be influenced by the role technology played in their secondary (high school) classrooms. Seventy-nine percent were not allowed to use technology in secondary classrooms while only 21% were allowed to use technology often in secondary classrooms. If teachers allowed students to use technology more in secondary and primary school, technology might become a more preferred note-taking method due to familiarity. Using technology for note-taking at an earlier age may have made it more natural, comfortable and preferred, thus leading students to record more notes accurately with technology.

Differences Between Traditional and Non-Traditional Post-Secondary Students.

Traditional and non-traditional age groups were compared, similar patterns among the percentage of responses was seen in the two groups. Most (63.2%) post-secondary students find themselves experiencing occasional fatigue, 47 (66.2%) and 20 (57.1%) from group 1 and 2 accordingly, yet students still prefer handwriting as a method of engagement for note-taking. This preference may be due to students perceiving themselves to retain information more accurately and thoroughly when writing over using other methods of note-taking as indicated by 63 (59.4%) participants in strong agreement and 29 (27.3%) in agreement. Forty (56.3%) and 23 (65.7%) of participants in group 1 and 2 believed information was better retained when handwritten. Fifty-five (77.5%) of participants in group 1 and 29 (82.9%) of participants in group 2 believed their note-taking was more accurate and on-topic when using pen and paper.

These findings show further support that handwriting is perceived to be an adequate and preferred note-taking method in the post-secondary classroom.

Participants between the traditional and non-traditional groups reported similar engagement in mature and immature grasp patterns. Seventy-six (107.1%) participants in group 1 and 34 (97.1%) in group 2 reported engagement in a mature grasp while only 9 (12.6%) and 4 (11.5%) accordingly reported using an immature handwriting grasp; participants were allowed to select more than one grasp. The non-traditional students were more likely to engage in a blended writing style, which uses components from the print and cursive style as some letters are strung together. Twenty-nine (40.8%) participants in group 1 and 25 (71.4%) in group 2 were found to use a blended style. This method enables students to string some letters together which in turn increases speed of transcription when recording notes. Graham, Weintraub and Berninger (1998) found those using a combination of print and cursive in their handwriting were faster writers than those exclusively using print or cursive. Furthermore, 36 (50.7%) and 8 (22.9%) of participants accordingly used print as the most preferred and only 6 (8.5%) and 2 (5.7%) in group 1 and 2 used cursive writing as the most preferred. Differences among traditional and non-traditional students may be due to a lack of understanding the blended style. As handwriting instruction has changed in the classroom, participants in group 2 who are older may have had a stronger cursive education and thus carried ideas into their print writing and blended the two styles.

Frequency of Handwriting in Post-Secondary Students for Personal Tasks. Twenty-nine percent of participants reported ideas of the importance of handwriting in everyday use based on ideas shared in their open-ended responses which were coded. Participants commonly recognized the personal nature and connection made with handwritten communication in a letter versus an email. When identifying the frequency of handwriting for personal use, a total of 21

items were completed daily by at least one participant. However, when looking at each item individually, the frequency of completing that task using handwriting skills has been identified. For each item, the frequency that is most commonly reported was highlighted in the results section (see Table 8). When looking at the tasks that were most frequently done in handwriting daily, three activities were identified: post-it notes/reminders, taking notes in general and a planner/calendar/daily schedule. These results are similar to findings for young adults with traumatic brain injuries surveyed between the ages of 20-24, who found the most common handwriting activities are messages, notes and lists (Gozzard, McCluskey, Lannin, & van Drempt, 2012). Participants and those from Gozzard et al. (2012) may have felt handwriting for particular tasks is more efficient, helps the brain better retain information or is simply preferred over technology. People may find something rewarding in being able to cross things off a list or calendar as it makes them feel more is being accomplished. These activities are also practices to help people stay organized and on top of tasks, which may indicate why handwriting for such activities is prevalent, for improved retention of the information. Among the 25 handwriting activities, 13 were rated highest as being activities for handwriting less than once a month. Due to the limitations of the question in the survey, it is unclear why participants may have responded in a particular manner. For instance, participants may only perform a certain activity once a week and thus only need to handwrite to perform it once a week. Future research could expand upon this question and decipher more about technology versus handwriting for personal tasks. Therefore, the interpretation and extrapolation of information reported from this question requires more investigation to make more detailed comments towards the degree handwriting is used for personal tasks.

Effective Methods for Accuracy and Quantity of Notes. Participants were asked to select note-taking methods which enabled more accurate and on-topic information and more information to be recorded within a given class period. Per report, pen and paper note-taking led to the most accurate, on-topic and more extensive set of notes according to 84 (79%) of the participants. Only 12 (20%) of participants preferred laptop use for a more accurate, on-topic and greater quantity set of notes. Aguilar-Roca, Williams, and O’Dowd (2012) found laptop users engaged in note-taking electronically due to the convenience and ease than for the learning benefit, and verbatim note-taking which predicts poorer performance in students (Mueller & Oppenheimer, 2014).

Post-Secondary Students Technology Usage

Based on participant responses regarding general use of technology, nearly all participants reported using a laptop and smartphone (95% and 94% respectively) while about half (45%) used a tablet/iPad and a quarter (26%) used a desktop computer. The specific type of use was not identified in the survey. The high usage rates for laptops and smartphones could be a result of the affluent background of students attending East Carolina University. Furthermore, resources on campus allow students who do not have their own laptop the option to loan a device for short periods of time and computer labs are prevalent as a resource to students with no additional cost. There have been significant changes seen in the development of universities in recent years. One of the shocking findings from the survey is 17% of participants using a smartphone claimed to use it 9 or more hours a day, which is likely higher than the amount of sleep some students get nightly.

Post-Secondary Student Opinions of Handwriting Instruction

Based on participant responses to open-ended questions and subsequent coding by the primary investigator, some participants viewed handwriting in everyday life (31 (29%)), handwriting in the post-secondary classroom (29 (27%)), and print instruction (24 (26%)) to be important rather than less important or not as necessary. Cursive handwriting instruction was the only instance where more participants viewed it as less important or not as relevant as has been in the past. Another common response was the idea that people retain information better and more accurately when writing and that writing requires more thought processing and concentration as reported by 49 (46%) of students for the post-secondary classroom. Participants further identified how handwriting aids in learning and reading, supports literacy, is a basic skill and aids in fine motor development for the primary student's education. Connections to increased focus and attention to task when handwriting were noted as students are more practiced in handwriting and can devote more brain power to the act of note-taking (Asher, 2006). Participants recognized many benefits for handwriting, especially at an early age in the classroom when exposed. As participants have identified, handwriting is believed to have many benefits for the young learner in their primary education and should continue to remain an element of the primary school curriculum.

Statistical Comparison of Groups of Post-Secondary Students

The series of chi square analyses conducted revealed no significant results. The findings assessed groups of participants using mature and immature grasps and groups of males and females. Therefore, this student found no relationship between a student's grasp and note-taking features as well as gender and note-taking features. The lack of significance indicates that at East Carolina University, no relationships were observed and thus no relationships can be extrapolated to the entire campus.

Implications for Occupational Therapists and Teachers

Recognizing post-secondary students' use of handwriting places importance toward primary teachers and school-based occupational therapists, when handwriting is instructed to students for its importance as a life-long skill students utilize throughout the post-secondary classroom. The educational system leaves most instructional requirements up to individual states to determine. However, it has been found consistent teaching leads to greater success with handwriting and teachers are often not prepared to teach handwriting (Graham et al., 2008; Donica et al., 2012). Consistency among teachers, grades, schools, states, and occupational therapists could positively impact each student's ability to find success with handwriting. Participants believe handwriting still has significance within the post-secondary classroom, which poses the importance for continued handwriting instruction at an early age to encourage continued development of the skill. Occupational therapists and teachers can therefore, begin to understand that handwriting will continue to have educational relevance for students throughout their entire educational career.

Data and previous research has shown continued support for the benefits of handwriting in allowing better retention and increased focus in the classroom (Feder & Majemer, 2007; Mueller & Oppenheimer, 2014). Participants believe handwritten notes not only enable better retention but allow more accurate and more notes overall to be recorded in a given class period. For teachers and occupational therapists alike, this preference of students should continue to provide support for the importance of teaching and focus on handwriting within the primary student population. School districts should continue to implement handwriting instruction curriculums. School based occupational therapists should continue to work with a student who is

displaying challenges with handwriting based on their grasp, legibility or speed in order to help the student excel at their primary occupation of education.

In the minds of certain individuals, writing is considered a technology, despite its lack of complexity. Writing involves the use of various symbols and requires use of physical effort to make a representation of language on the page (MacArthur, 2006). Students need to have a minimal understanding of spelling, at least a fifth grade level, in order to correctly select words with a word processor (Penhorwood, 2012). The practice of handwriting will continue to reinforce these skills for students. Despite advancements of spell check and auto correct, it does not always correctly identify words and spelling for the desired word. When limited to pen and paper, students will be required to rely on brain power to spell correctly and select correct words. When students are older and have further developed literacy skills, the classroom can implement technology, at which point students will have the necessary skills to best utilize the technology to their advantage to support learning.

Jason Nolan, a professor of early childhood stated, “Present tools are no better than those of the past if they are not put to good use” (Penhorwood, 2012, para. 29). The use of technology is changing the way we communicate with each other and how we view the world (MacArthur, 2006). The role of technology as viewed by students needs to continue to be assessed by educators and occupational therapists to determine best practices. As educators and occupational therapists monitor student perceptions and assess methods for better success, decisions for continued educational goals will become clearer and methods that are most effective could be revealed.

As occupational therapists and teachers, it is important to realize technology is not inherently detrimental to students, but should be used appropriately in conjunction with

traditional handwriting to help students maximize the learning process. Technology can provide the opportunity to develop cognitive skills and social interactions depending upon the interaction of the technology, social context and individual (MacArthur, 2006). With the proper introduction and monitored use, technology could play a vital role in the classroom. Handwriting and technology both play a role in the classroom and the everyday world, but an optimal balance needs to be found.

Handwriting was reported as being needed for daily tasks in addition to classroom note-taking by post-secondary students. It is important to remember as occupational therapists and teachers that teaching students the skill of handwriting will benefit the individual in occupations beyond education to allow for greater social interaction and communication. Handwriting will support literacy skills that will continue to expand and develop across the lifespan to encourage appropriate written and verbal communication.

The introduction of new technologies is enabling students to not just consume or read anymore, but to write and produce (MacArthur, 2006). The use of technology in the classroom does not come without barriers. A lack of access to computers and software, insufficient time to plan instruction, and inadequate technical and administrative support can influence the integration of technology (Ertmer et al., 1999). Barriers also arise from the beliefs about teaching, beliefs about computers, established classroom practices and an unwillingness to change (Ertmer et al., 1999). Often teachers view computers as a support or hindrance to the classroom environment (Ertmer et al., 1999). Occupational therapists and teachers alike must continue to fight for the integration of handwriting instruction and use in the primary classroom for students to grow and learn and reap the benefits.

Recommendations for Future Research

In order to move forward with determining the effectiveness and role handwriting has at the post-secondary level, similar research could be conducted with a larger student population from various universities. A private or smaller university might show students have more access to technology or different opinions of handwriting and its use in the classroom. Furthermore, a secondary survey could be created to disperse to professors. It would be interesting to see if professors report students using note-taking methods in different increments than students report. For example, do professors feel students are using technology more even though students report using handwriting more often to take notes?

In looking to expand the knowledge, the current generation of post-secondary students was born and grew up as the technology progression expanded. If this survey was repeated in 5 or 10 years, results may greatly differ as students could have been introduced to technology both inside and outside the classroom at an earlier age making it more natural to use than handwriting. The prevalence of technology will continue to vary for the coming generations. In 2003, Wilson, Notar and Yunker talked about how teachers were not integrating technology into the primary school curriculum, however, that was over 10 years ago. Technology has advanced more since then and the classroom has drastically changed. Wilson et al. (2003) believed despite the opportunities teachers have to utilize technology in teaching, many business leaders, parents and educators did not believe the educational system was preparing students for the changes of the technological world. Despite professor limited restrictions on technology in the classroom, how will the use of technology impact student success and learning and the development of other foundational skills such as reading and arithmetic?

Another component of the inclusion of technology in the classroom to consider is the student and his or her abilities. For students who have learning disabilities or other diagnoses,

technology may be the only option they are willing or able to use in order to communicate in writing. Writers with learning disabilities find the use of word processing very helpful when they are trying to word find (MacArthur, 2006). Students who struggle in the classroom will require more motivation, and word processing allows more support for these students with mechanics, appearance and revising. The use of spell check, word prediction, speech synthesis, and speech recognition can also allow students to engage more (MacArthur, 2006).

Further identification of the differences between the use of technology and handwriting for personal tasks could be expanded. In discussing the findings of the frequency of handwriting use for personal tasks, many factors were not assessed in regards to student preferences. Continued research could address if and how often technology may be used instead of handwriting for personal tasks, as technology was not assessed in great detail for personal use.

Limitations of the Study

Due to constraints placed by the Survey Review and Oversight Committee non-preferred changes were made by the primary researcher. The committee stated changes be made in order to approve it for distribution and encourage more student participation by cutting back on the number of questions. A pilot study had already been done when changes recommended by the Survey Review and Oversight Committee were made. Committee members also encouraged further clarification and word changes to increase the chance of getting the participants to understand and answer as intended. The survey originally included more questions to seek detailed information related to each participant's educational background as well as their preferences and experiences pertaining to handwriting. As questions were cut from the final survey less information was determined making the survey not as informational as intended. It

would have been ideal to bring the survey before the committee prior to the pilot study to indicate what questions were essential and how to limit the length of the survey.

Furthermore, due to the nature of the study as a survey, participants were not observed while answering the questions. There is always a chance that participants may not have answered honestly. Participants may have skewed their responses to favor handwriting more or less based on their own opinions or because they were answering a survey investigating handwriting. While answering questions, the chance for systematic error, or error due to the survey as an instrumentation tool, may have been present. Systematic error could have resulted from not experiencing enough preliminary testing to ensure the validity and reliability of the questions prior to data collection. If the pilot study had included more participants, the strength of validity and reliability for the survey could have been greater leaving less room for error in data collection.

The number of participants, despite continued reminder emails, may not have yielded a high enough response rate to accurately stratify the opinions found to the entire student population at East Carolina University. Individuals selected may have been full-time post-secondary students, students going back to school, or part-time students with other obligations, and thus did not have a desire to complete the survey since it did not serve a purpose for class. Furthermore, the random sample could have been restricted to those 30 years-old and younger to start to decrease the chance of tossing out responses due to exclusionary criteria. Students' who took the survey may have had stronger opinions on the need or lack thereof for handwriting today. If that was the case, individuals who feel indifferently towards handwriting may not have voiced their opinions. Since the preferred and desired number of participants was not met the

degree of generalizability of the results is not high. Therefore, conclusions are not as credible for the potential for accuracy.

Continuing with the concept of generalizability, due to the degree of convenience with this study sampling one university campus, the results are not capable of being stratified to other campuses with confidence. There might be differences in responses seen in a smaller university, a private university or even a community post-secondary institution. The students used in this study are not an accurate representation of every post-secondary student population. Results are somewhat generalizable to the East Carolina University student population based upon the variability of students who completed the survey and their representation of the whole student population.

Conclusion

In conclusion, participants engaging in handwritten note-taking consisted of all ages of young adults, different levels of study, gender and handwriting grasps. The participants viewed handwriting as an important and preferred note-taking method at East Carolina University. Compared to other note-taking methods, handwriting enabled more accuracy, a greater quantity and better retention of the information taught. Handwriting was found to be used outside of the classroom for a variety of tasks ranging from monthly to daily in frequency, but exact use of handwriting over technology as a preferred method for personal tasks is unclear due to the limited information collected in the survey.

Data showed laptops and smartphones were highly popular with young adult post-secondary students at East Carolina University. Participants reported using technology less frequently in the context of the classroom. Despite the implementation of technology in the

classroom, students relayed mixed reports of being allowed to utilize technology within the classroom for note-taking purposes.

Within the personal and classroom environment, participants reported there is importance for handwriting, specifically for print instruction at the primary level. Most students find cursive writing beyond signing your name to be irrelevant or not as important but still important to keep in primary curriculums. Young adult students viewed print handwriting to be an important component of the primary curriculum as it will be a skill that is called upon later in life for both education, career and overall communication. The data collected provides support for the continued importance handwriting holds for a post-secondary student and thus how handwriting instruction at the primary level is necessary and should remain a component of the curriculum. Further analysis of groups of post-secondary students revealed no significant associations among responses related to handwriting in the classroom for note-taking purposes.

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APPENDIX A: HANDWRITING’S ROLE IN THE 21ST CENTURY SURVEY

12/2013

Qualtrics Survey Software

Default Question Block

Dear Participant,

I am a student at East Carolina University in the Occupational Therapy department. I am asking you to take part in my research study entitled, “*Handwriting in the 21st Century.*”

The purpose of this research is to gain an understanding of the opinions that current students at East Carolina University hold in regards to the role and relevance of handwriting in the 21st century with technological advancements that are changing the way students engage in the classroom. By doing this research, I hope to learn what methods are most used by students for taking notes in class and what implications are leading students to choose certain methods for note taking. The results will be compared across educational level, gender, handedness, age and writing grasp.

You have been invited to take part in this research because your email address was randomly selected to be shared the link from all current student email addresses at East Carolina University. This survey has been created specifically for use with a master thesis project being completed at East Carolina University. All answers to the survey questions will be analyzed anonymously and your participation is voluntary. The amount of time to complete this survey is approximately 15-20 minutes. The survey includes Likert scale questions, multiple choice, yes/no and open ended questions.

Since this research is overseen by the ECU Institutional Review Board, some of its members or staff may need to review my research data. However, the information you provide will not be linked to your name or identity in any way. Therefore, your responses will not be traced back to you by anyone, including the primary researcher.

If you have questions about your rights as someone taking part in research, you may call the UMCIRB Office at phone number 252-744-2914 (days, 8:00 am-5:00 pm). If you would like to report a complaint or concern about this research study, you may call the Director of UMCIRB Office, at 252-744-1971.

You do not have to take part in this research, and you can stop at any time. If you decide you are willing to take part in this study please check AGREE below and the survey will begin on the next page. If you are under the age of 18 please select DISAGREE below as you are not eligible to participate in the study. Thank you in advance for taking the time to participate in my research!

Courtney Spencer
 spencerc13@students.ecu.edu
 (774) 535-3293

- Agree
- Disagree

Handwriting Mechanics

Please select and drag each of the following items into a category on the right hand side based on how often you use handwriting for the given task.

<p>Items</p> <ul style="list-style-type: none"> Birthday Cards / Greeting Cards Data Collection for Work Exams/Quizzes Forms (School, Sports, Tax, etc.) Grading Papers/Peer Reviewing Job Applications Journal / Devotional Labeling Personal Items - clothing, 	<p>Less than Once a Month</p>	<p>Once a Month</p>
---	--------------------------------------	----------------------------

Appendix A

1/12/2013

Qualtrics Survey Software

- casserole dish, etc.
- Marking Photos - names & dates
- Medical Forms
- Meeting Notes
- Messages from Voicemail
- Notecards for learning, textbook notes
- Notes (Thank You, Encouragement, General)
- Planner / Calendar / Daily Schedule
- Post it Notes/Reminders
- Recipes
- Signing Documents
- Taking Notes - in general
- Task Instructions
- To Do Lists, Shopping Lists, etc.
- Travel Directions
- Whiteboard / Dry Erase Board
- Writing Letters / Addressing Envelopes
- Writing & Signing Checks, Signing Credit Card Receipts

2-3 Times a Month
Once a Week
2-3 Times a Week
Daily
Never/Not Applicable

Please include additional reasons that you use handwriting for if it was not mentioned in the previous question.

I hold and use a writing utensil with a grasp similar to _____ pictured below. If you use more than one grasp often, choose the two most similar to your grasps from the images displayed.

*Note how the fingers rest on the pencil to compare.

Appendix A

12/2013

Qualtrics Survey Software

Figure 1



Figure 5



Figure 2



Figure 6



Figure 3



Not displayed, please describe

Figure 4

Appendix A

1/26/15

QUANTICS Survey Software



What is your current enrollment at East Carolina University?

- Full time student
- Part time student
- Other

What is your gender?

- Male
- Female

Which of the following best describes your current status as a student?

- | | |
|---|--|
| <input type="radio"/> Undergraduate Freshman | <input type="radio"/> Graduate Student Year 3 |
| <input type="radio"/> Undergraduate Sophomore | <input type="radio"/> Graduate Student Year 4 |
| <input type="radio"/> Undergraduate Junior | <input type="radio"/> Non-degree seeking student |
| <input type="radio"/> Undergraduate Senior | <input type="radio"/> Certificate student |
| <input type="radio"/> Graduate Student Year 1 | <input type="radio"/> Other |
| <input type="radio"/> Graduate Student Year 2 | |

What is your race?

- | | |
|--|--|
| <input type="radio"/> African American | <input type="radio"/> Caucasian |
| <input type="radio"/> Alaskan Native | <input type="radio"/> Hawaiian & Pacific Islands |
| <input type="radio"/> American Indian | <input type="radio"/> Prefer not to respond |
| <input type="radio"/> Asian | <input type="radio"/> Other |

Based on my personal interpretation and that of my peers and teachers, my handwriting is legible.

- 1 - Strongly Disagree
- 2 - Disagree
- 3 - Neutral
- 4 - Agree
- 5 - Strongly Agree

Handwriting and Injuries

I have suffered or am currently suffering from a serious injury in the hand or wrist.

- Yes
 No

I have suffered or am currently suffering from the following diagnosis. Choose ALL that apply.

- | | |
|---|--|
| <input type="checkbox"/> Carpal Tunnel Syndrome | <input type="checkbox"/> DeQuervain's Syndrome |
| <input type="checkbox"/> Wrist Fracture | <input type="checkbox"/> Tendonitis |
| <input type="checkbox"/> Thumb Sprain | <input type="checkbox"/> Chronic Dislocations |
| <input type="checkbox"/> Wrist Sprain | <input type="checkbox"/> Chronic Sprains |
| <input type="checkbox"/> Hand Fractures (Palm or Fingers) | <input type="checkbox"/> Other |
| <input type="checkbox"/> Finger Dislocations | |

If I did not have a past or current injury to my hand or wrist, I would be more likely to engage in handwriting.

- Yes
 No

As a result of my injury, I had to learn a new grasp for handwriting.

- Yes
 No

If you were unable to write after your injury temporarily, or are unable to write now due to injury, how did or are you completing tasks requiring handwriting?

Handwriting, Technology, and College

With school-related handwriting tasks (ie note-taking, exams), I experience *discomfort/fatigue*.

- Not At All
 Occasionally
 Frequently

I prefer the following method(s) to take notes in class. Choose ALL that apply.

- Handwriting
 Computer/Typing
 Audio Recordings
 Other

I utilize handwriting to take notes in class _____ of the time.

- 0% - 24%
 25% - 49%

Appendix A

1/2/2015

Qualtrics Survey Software

- 50% - 74%
- 75% - 100%

I utilize computer typing to take notes in class _____ of the time.

- 0% - 24%
- 25% - 49%
- 50% - 74%
- 75% - 100%

I utilize audio recordings to record information in class _____ of the time.

- 0% - 24%
- 25% - 49%
- 50% - 74%
- 75% - 100%

I feel that handwriting is no longer necessary in the 21st century.

- 1 - Strongly Disagree
- 2 - Disagree
- 3 - Neutral
- 4 - Agree
- 5 - Strongly Agree

I retain information more accurately and thoroughly when I write it down.

- 1 - Strongly Disagree
- 2 - Disagree
- 3 - Neutral
- 4 - Agree
- 5 - Strongly Agree

Which of the following technological devices do you use? Choose ALL that apply.

- Tablet/iPad
- Laptop
- Desktop Computer
- Smartphone

I use a tablet/iPad approximately _____ hours in a day.

- 0 - 2 hours
- 3 - 4 hours
- 5 - 6 hours
- 7 - 8 hours
- 9+ hours

I use a laptop approximately _____ hours in a day.

- 0 - 2 hours
- 3 - 4 hours

Appendix A

Survey Software

- 5 - 6 hours
- 7 - 8 hours
- 9+ hours

I use a desktop computer approximately _____ hours in a day.

- 0 - 2 hours
- 3 - 4 hours
- 5 - 6 hours
- 7 - 8 hours
- 9+ hours

I use a smartphone approximately _____ hours in a day.

- 0 - 2 hours
- 3 - 4 hours
- 5 - 6 hours
- 7 - 8 hours
- 9+ hours

I find my note taking to be most accurate and on topic when I use a _____.

- Tablet
- Laptop
- Smartphone
- Pen and paper, handwriting
- Other

I find myself to be able to take more notes in a class period if I take notes with a _____.

- Tablet
- Laptop
- Smartphone
- Pen and paper
- Other

I had the option to use technology to take notes during class in high school.

- Yes
- No

I had/have the option to take notes using technology during my college classes, even if only for some classes.

- Never
- Rarely
- Sometimes
- Often
- All of the Time

Briefly explain from your experience what note taking methods professor's allow in class or what methods professor's encourage students to use most often in college courses.

What importance do you think handwriting has in EVERYDAY LIFE during this current expansion in technology? Please explain.

What importance do you think handwriting has in the CLASSROOM during this current expansion in technology? Please explain.

Do you think the education for print handwriting is still an important component that should remain in the elementary grade level curriculum? Please explain.

- Yes
- No

Do you think cursive education is still an important component that should remain in the elementary grade level curriculum? Please explain.

- Yes
- No

Demographics

What is your age?

I am currently taking _____ credits of course work.

- 0-3 credits
- 4-6 credits
- 7-9 credits
- 10-12 credits
- 13-15 credits
- 16 or more credits

What is your current cumulative GPA?

What is your handedness?

- Left
- Right
- Ambidextrous

What is your preferred writing style?

- Print
- Cursive
- Blended - Mix of Print and Cursive
- Other

APPENDIX B: SURVEY CONSENT FORM

Dear Participant,

I am a student at East Carolina University in the Occupational Therapy department. I am asking you to take part in my research study entitled, "*Handwriting in the 21st Century*."

The purpose of this research is to gain an understanding of the opinions that current students at East Carolina University hold in regards to the role and relevance of handwriting in the 21st century with technological advancements that are changing the way students engage in the classroom. By doing this research, I hope to learn what methods are most used by students for taking notes in class and what implications are leading students to choose certain methods for note taking. The results will be compared across educational level, gender, handedness, age and writing grasp.

You have been invited to take part in this research because your email address was randomly selected to be shared the link from all current student email addresses at East Carolina University. This survey has been created specifically for use with a master thesis project being completed at East Carolina University. All answers to the survey questions will be analyzed anonymously and your participation is voluntary. The amount of time to complete this survey is approximately 15-20 minutes. The survey includes Likert scale questions, multiple choice, yes/no and open ended questions.

Since this research is overseen by the ECU Institutional Review Board, some of its members or staff may need to review my research data. However, the information you provide will not be linked to your name or identity in any way. Therefore, your responses will not be traced back to you by anyone, including the primary researcher.

If you have questions about your rights as someone taking part in research, you may call the UMCIRB Office at phone number 252-744-2914 (days, 8:00 am-5:00 pm). If you would like to report a complaint or concern about this research study, you may call the Director of UMCIRB Office, at 252-744-1971.

You do not have to take part in this research, and you can stop at any time. If you decide you are willing to take part in this study please check AGREE below and the survey will begin on the next page. If you are under the age of 18 please select DISAGREE below as you are not eligible to participate in the study. Thank you in advance for taking the time to participate in my research!

Courtney Spencer
spencerc13@students.ecu.edu
(774) 535-3293

Appendix C

APPENDIX C: EMAIL INTRODUCTION

Please take a few minutes to complete the following student survey if you have not done so already. The survey will close in one week on **Sunday April 19 at 11:59pm**. Your participation is greatly appreciated for completion of a student's master thesis research!

You have been randomly selected to participate in a survey. The purpose of this survey is to gain an understanding of the opinions that current undergraduate and graduate level students at East Carolina University hold in regards to the role and relevance of handwriting in the 21st century with technology that is shaping the way students engage in their education. The primary researcher aims to determine what methods are most used by students for taking notes in class and what implications are leading students to choose certain methods for note taking. The results will be compared across educational level, gender, handedness, age and writing grasp.

This study is being used for the purpose of a graduate student's master thesis which aims to make an informative recommendation for occupational therapists specifically and potentially teachers, in regards to the role of instructing students in handwriting at an early age. This study will help to determine how effective and how often handwriting is used in the later stages of education. By understanding the relevance of handwriting in later educational stages it can help professionals to understand how important it is to focus on handwriting instruction at younger ages. If future educational engagements do not require the use of handwriting it may not be an effective use of time for treatment with a student. Results could help determine and construct ideas for teachers and therapists alike about the importance of handwriting grasp for continued use of handwriting in the future for educational purposes.

This knowledge could assist occupational therapists in creating more effective and relevant treatment plans for elementary, middle and potentially high school students. If you are willing to participate please click on the link below to begin. You do not have to take part in this research, and you can stop at any time. If you are under the age of 18 please do not continue as you are not eligible to participate in this study. Thank you in advance for taking the time to participate in my research!

Courtney Spencer
spencerc13@students.ecu.edu
(774) 535-3293

APPENDIX D: HANDWRITING GRASPS

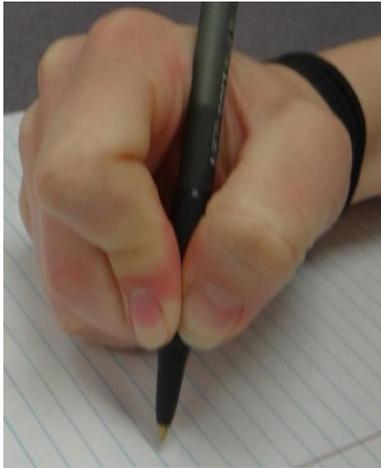


Figure 1: Dynamic Tripod



Figure 2: Dynamic Quadrupod



Figure 3: Lateral Tripod



Figure 4: Lateral Quadrupod



Figure 5: Four Finger



Figure 6: Interdigital

APPENDIX E: IRB APPROVAL



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

Notification of Amendment Approval

From: Social/Behavioral IRB
To: [Courtney Spencer](#)
CC: [Denise Donica](#)
Date: 3/10/2015
Re: [Ame1_UMCIRB 14-000572](#)
[UMCIRB 14-000572](#)
Handwriting in the 21st Century

Your Amendment has been reviewed and approved using expedited review on the date of 3/10/2015. It was the determination of the UMCIRB Chairperson (or designee) that this revision does not impact the overall risk/benefit ratio of the study and is appropriate for the population and procedures proposed.

Please note that any further changes to this approved research may not be initiated without UMCIRB review except when necessary to eliminate an apparent immediate hazard to the participant. All unanticipated problems involving risks to participants and others must be promptly reported to the UMCIRB. A continuing or final review must be submitted to the UMCIRB prior to the date of study expiration. The investigator must adhere to all reporting requirements for this study.

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

The approval includes the following items:

Document	Description
Survey 3.4.15.pdf(0.01)	Surveys and Questionnaires

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