The Effects of a Word Prediction Program on the Number of Words Written by a Learner with Disabilities

Thesis

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Abstract

The research investigated the effect of word prediction program on quantity of writing of a tenth grade student who was experiencing writing problems. The A-B-A-B design was used with each session divided into two parts- copying text and descriptive writing. The word processor was used in the baseline sessions and word processor with word prediction in the treatment sessions. Evaluation was done by counting total typed words (TTW) and total spelling errors (TE). The typing rate across sessions across different tasks was also compared. The participant’s TTW and TE in copying text insignificantly varied across sessions across different tasks. In descriptive writing, the participant’s TTW decreased during treatment, however spelling errors insignificantly varied. The participant also noted the benefits of word prediction program; however, its use is limited because of the need of training learners and teachers, and adapting it to participants’ needs, and availing it when needed.
Dedication

Dedicated to my parents in Kenya Boniface Obwamo Ressa and Ursula Ong’amo Ressa.
Acknowledgements

I would like to extend my gratitude to several people who without their help and support, accomplishment of this thesis would not have been possible.

Primarily, my thanks go to my academic advisor, Dr Joseph Wheaton for his untiring search for participant, processing of IRB form, provision of computer, and guidance before, during, and after the research period. Were it not for his detailed comments and insights, this final document may not have been realized. I extend my special thanks to the School of Physical Activity & Educational Services (PAES) for their confidence in me that made me focus on my academic work. Appreciations also go to the student for his participation. I am also indebted to my second reader, Dr. Ralph Gardner for his detailed comments.

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Continued
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Focus: Applied Behavior Analysis and Disability Studies and Policy

Specialization: Assistive Technology/ Teacher of English and Literature
# Table of Contents

Abstract .............................................................................................................................................. ii
Dedication ........................................................................................................................................ iii
Acknowledgements .......................................................................................................................... iv
Vita .................................................................................................................................................... vi
List of Tables ..................................................................................................................................... x
List of Figures ................................................................................................................................. xi
Chapter 1: Introduction ....................................................................................................................... 1
  Outline of the Thesis ....................................................................................................................... 3
  Literature Review ............................................................................................................................. 4
  Statement of Problem ..................................................................................................................... 15
  Statement of Purpose ..................................................................................................................... 15
  Research Hypotheses ..................................................................................................................... 15
  Assumptions ................................................................................................................................... 16
  Delimitation .................................................................................................................................... 16
  Rationale for the Research ............................................................................................................. 17
Chapter 2: Method .............................................................................................................................. 19
  Participant ....................................................................................................................................... 19
Setting .......................................................................................................................20
Experimenter .............................................................................................................21
Materials and Equipment ..........................................................................................21
Definition and Measurement of Dependent Variables .............................................21
Independent Variable ...............................................................................................22
Experimental Design .................................................................................................23
Response Measurement and Interobserver Agreement (IOA) ..............................23
Procedures ..................................................................................................................25
Intervention Phase .....................................................................................................27
Procedural Integrity ...................................................................................................28
Social Validity .............................................................................................................29

Chapter 3. Results .....................................................................................................31

Interobserver Agreement ..........................................................................................31
Research Hypothesis 1: Word prediction increases quantity of writing. ...............31
Research Hypothesis 2: Word prediction increases typing accuracy .......................38
Research Hypothesis 3: Word prediction increases typing speed. ..........................42
Research Hypothesis 4: Word prediction increases participant’s satisfaction
with writing tasks ........................................................................................................46

Chapter 4. Discussion ...............................................................................................47

Research Hypothesis 1: Word prediction increases quantity of writing. ...............47
Research Hypothesis 2: Word prediction increases typing accuracy. .......................49
Research Hypothesis 3: Word prediction increases typing speed. .........................53
List of Tables

Table 3.1. Performance data. .................................................................33
Table 3.2. Comparison of performances across sessions across tasks........34
Table 3.3. Means across sessions across tasks........................................35
Table 3.4. Accuracy percentage data......................................................41
Table 3.5 Rate of typing across sessions across tasks. ............................43
List of Figures

Figure 3.1. The total typed words and total errors made during training, baseline, and treatment when participant copied text. ..........................................................36

Figure 3.2. The total typed words and total errors made during training, baseline, and treatment when participant wrote descriptive paragraph. ........................................37

Figure 3.3. The accuracy percentage of copying text with and without word prediction. ........................................................................................................39

Figure 3.4. The accuracy percentage of descriptive writing with and without word prediction. ........................................................................................................40

Figure 3.5. The rate of copying text during training, baselines 1 and 2, and treatments 1 and 2. ..........................................................44

Figure 3.6. The rate of descriptive writing during training, baselines 1 and 2, and treatments 1 and 2. ..........................................................45
Chapter 1: Introduction

Problems in writing interfere with generation of ideas, and are the contributing factors in students’ poor performance. A report by The National Commission on Writing in America’s schools and colleges (2003) indicates that teaching writing have been neglected and the numbers of students in higher grades who cannot write competently are on the rise, whereas quality writing in schools determines success in college and beyond. Once acquired, however, writing skills transcend into daily life of an individual thereby producing reinforcement from the natural environment. Writing commercial articles, leisure articles, and e-mails enable students to apply for jobs, fill out forms, and review academic and nonacademic materials. Furthermore, writing, especially on the internet, opens the whole world to students during and after school enabling them to socialize with people, both in the yonder and opposite the globe. Because writing skills are applicable to a wide range of teaching activities and social life, its effect is invaluable.

Research on word prediction as a writing aid for students with writing problems has used learners with or without disabilities, and the outcome variables have focused on one or two of the following areas: writing speed, keystroke saving, quantity and quality of writing, and attitude of learners to writing. Other research have focused on the use of word prediction in text entry strategies, and whether it narrowed the achievement gap in
writing performance between learners with writing problems and their general education
grade peers and whether that improvement led to greater social acceptance by their peers.

Students who experience writing problems exhibit different characteristics, but
generally they avoid writing comprehensively thus leaving out important points in their
essays, or they fail to develop the points persuasively (Applebee & Langer, 2006), which
affects their competitiveness and chances of joining colleges and employment. Although
Applebee and Langer’s research did not focus on students with disabilities, it is thought
that students with disabilities are at a greater risk, because the challenges they face as a
result of physical and mental limitations affect their handwriting, keyboarding, typing,
and generation of ideas which in extension affect the quality and quantity of their final
written work. Because computers have become integral in people’s lives as a means of
communication, a means of accessing information, a means of performing work and
school assignments, educators have switched to them to address some of the writing
challenges. However, these students still face problems of writing accurately, writing
more, and spending more time writing. Nevertheless, use of word processor with word
prediction program has made it possible for these students to write long and high quality
essays. Then the efficacy of the word prediction is determined by the human-computer
interface: competency of typing a letter, scanning the prediction list, choosing a word,
and ascertaining whether it is the correct one, may affect rate of production and thus
quality and quantity of finished product. Besides, the effectiveness of predictive systems
in practical use may depend on details of the screen layout.
To check writing problems, schools have adopted assistive technologies (ATs) to assist students with disabilities. Although ATs such as computers and word prediction programs make writing easier and simpler (Jutai & Day, 2002), students with disabilities still face greater challenges with writing (Olson, 2006). Despite individualized education program (IEP) team’s involvement in recommendation and provision of ATs, research provide evidence of dissatisfaction, disuse, and/or abandonment of devices by users (Batavia & Hammer, 1990; Scherer & McKee, 1989). Moreover, as Batavia and Hammer observed, users are less likely to use recommended devices when they are not meeting their needs. With this understanding, there is need of constant reevaluation of the efficacy of the devices to ascertain whether it is meeting consumer’s needs (Demers, Weiss-Lambrou, & Ska, 1996; Reid, Rigby, & Ryan, 1999).

Outline of the Thesis

Chapter 1 deals with introduction, outline of the thesis, literature review, assumptions, delimitation, rationale for the study, and research questions. Chapter 2 is method: participant, setting, experimenter, materials, definition and measurement of dependent variables, independent variable, experimental design, response measurement and interobserver agreement, procedures, procedural integrity, and social validity. Chapter 3 gives the results of the study. Chapter 4 is a discussion followed by implications, limitations of the research, and suggestions for future research, summary, and conclusions. These are followed by references, glossary of terms, abbreviations, and appendices, respectively.
Literature Review

Writing is multimodal interactions that involves neurological process that concurrently and successively integrate attention, information sources, memory, language, motor and cognitive skills (Kay, n.d; MacArthur, 1999b), consequently a slight interference with neural network can lead to poor handwriting skills, typing problems, difficulties in planning, organizing, revising, and editing texts (Hallenbeck, 1996; MacArthur & Graham, 1997). Since writing, reading, and spelling are intertwined (Zhang & Brooks, 1995), a student who has trouble in one area tends to fail in other related areas; ultimately, the student experiences general academic failure (Tam, Reid, Naumann & O’Keefe, 2002b).

Although typical students find writing challenging, students with disabilities find it overwhelming. For instance, children with learning disabilities find piecing enough, relevant, and flowing ideas together for a purpose; to describe or expository or persuade, in a format directed to a particular audience, problematic (Bigelow, 2008; Montgomery & Marks, 2006; Williams, 2002). Incidentally the number of children with special needs (including those with writing problems) in the general education classrooms have been increasing since the laws on education, No Child Left Behind Act (NCLB; 2001) and the Individuals with Disabilities Education Act (IDEA; 1997, 2004), were reenacted (Sitlington, 2008). Because these laws require students with disabilities to participate in district and statewide testing and because the states are required to submit adequate yearly progress, schools have been forced to develop accommodations by adopting use of
AT to alleviate the challenges students with writing and reading problems face when taking tests.

Adoption of computers as a classroom aid, and advancement in computer technology has led to production of cheaper efficient models thus making them affordable and available in US schools (Becker, 1999). This has seen the number of computers in the schools increase markedly from a ratio of 125 students to one computer in 1983 to 4.2 students for one computer in 2001 (Glennan & Melmed, 1996; Market Data Retrieval, 1999, 2001). In South Dakota, the ratio of student to computer is even lower – 2:1 (Bennett, 2002). This is a boon because many programs, including word prediction program work in conjunction with computers. However, research shows that use of word prediction program is hampered by its unavailability in schools (because little value is placed on the technology), the rate of technology change, and need to train learners and teachers on its use.

A word prediction program guesses a whole word from a list of words when a user types a letter. It narrows down to a likely word as more letters are typed. If the user selects one of the suggested words, the word is inserted into the text, and the user can proceed to type the next word. This saves the user from typing the whole word thereby saving the user the keystrokes, spelling errors, fatigue, while enhancing user’s typing speed and quantity and quality of work (Fazly, 2002; Herold, Alant, & Bornman, 2008; Lang, 2001; Newell, Arnott, Booth, Beattie, Brophy, & Ricketts, 1992). In fact, word prediction program has been used to reduce the amount of effort needed for a person with
a physical disability to produce written work (Heckathorne, Voda, & Leibowitz, 1987; Hunnicutt, 1986; Newell et al., 1992; Swiffin, Arnott, & Newell, 1987).

Word prediction program can be used together with other assistive devices such as keyboards, virtual keyboards, speech synthesizer, touch pads, and other pointing devices, such as computer mouse, head mouse, and eye mouse (Aliprandi, Carmignani, & Mancarella, 2007).

Despite their functional differences, word prediction programs have common features, which include dictionary, auto learn, abbreviation expansion, grammar checker, mechanism to hide word choices, mechanism to predict in-line or predict ahead, mechanism to choose by number or by pointer, speech synthesizer, delete/modify, scanning, and latching features. The latching allows typing with a single finger or pointer. In some programs, words are arranged either alphabetically or according to frequency, with fixed or dynamic prediction list, and with changeable font, number, and window size. Other word prediction programs have spacing feature that inserts a space between the words. This auto-spacing saves users additional keystroke for every word selected from the prediction list. But as Tam et al. (2002a) confirmed, unless well trained students may automatically press the spacebar at the end of each word thus creating an additional space, and decreased overall accuracy.

However, each program has a unique feature that differentiates it from others. For example, features of Co:Writer (Don Johnston) include predict ahead, dictionary, speech feedback, spelling checker, grammar checker, scanning, and multiple writer files (Williams 2002; Mirenda, Turoldo, & McAvoy, 2006). Besides, Co:Writer 4000 has
extra features such as flexible spelling – in which words are predicted from phonetic spelling (for example, typing foto or ftgraf will cause the program to predict the word photograph). Other word prediction programs that have been employed in researches include Write This Way, Write:OutLoud, Read & Write, Wordsmith (TextHelp!), Kurzweil 3000 (Kurzweil), Penfriend W3 1.04, LetMeType, Windmill, Intelligent Word Prediction Project, KeyREP, WriteAway 2000, TextHelp, and FASTY.

Studies on word prediction have involved different categories of students: students with learning disabilities (LD; Lewis, 1998; MacArthur, 1999a; Williams, 2002), students with physical disabilities (Anson et al., 2006; Lang, 2001; Mirenda et al., 2006; Tumlin & Heller, 2004), students with dyslexia (Gustavii & Pettersson, 2003), students with spina bifida and hydrocephaly (Tam et al., 2002 a, b), and students with dysgraphia. Although other studies have involved typical participants to deduce the performance of students with disabilities, researchers should cautiously extrapolate quantitative data derived from experiments with able-bodied persons in laboratory settings because different users employ different strategies to compensate for deficiencies (Newell, Arnott, & Waller, 1992). Nevertheless, the research results have influenced recommendation of word prediction program to students with writing problems and improvement of the software.

Studies on word prediction as a text entry device for students with writing problems have experimented with learners either with or without disabilities, and the outcome variables focused on one or two discrete variables: writing speed, keystroke saving, quantity and quality of writing, accuracy, and attitude of learners to writing.
Other experiments have also focused on whether the use of text entry strategies narrowed the achievement gap in writing performance between learners with writing problems and their general education grade peers without disabilities, and whether that improved their acceptance by peers. As such the research have yielded different results because of differences in research methodologies, research populations, user characteristics, type of computer access devices, type of word prediction software (Herold et al., 2008; Tam et al., 2002b), length of participant training (Horstmann & Levine, 1992), and the interaction of these aspects.

However, as Williams (2002) observed, the divergences in the research may be an operation between instructional methodologies and instructional feedback that follows the use of word prediction, not necessarily efficacy of the technology, this because its efficacy is determined by the individual’s ability to choose a word and ascertain whether it is the correct one. The efficacy also depends on language because different languages have different structures that determine lexical entry hence keystrokes (Hunnicutt & Cardlberger, 2001). Equally, user parameters such as the degree and type of disability, age, sex, competence and/or cognitive load imposed on the user by the system, the number of words in the prediction list, the position of the prediction window, have been found to influence user satisfaction (Wester, 2003). Of importance has been the screen layout and keyboarding skills because typing and scanning the prediction list determine fatigue and rate of production. In keyboarding, the user has to know the position of the keys in relation to the motor coordination to get the visual-kinesthetic feedback with

Reduced cognitive load and accurate word prediction was found to depend on initial letter. Therefore, it is necessary for the user to type the initial letter of the word correctly before the appropriate word can appear (MacArthur, 1998a). Otherwise, as Tumlin and Heller (2004) noted, failure of word prediction program to predict correctly the intended word by not including the participant’s target word in the group of words it displays may mean the participant using more keystrokes and/or choosing a wrong word. In addition, where a participant combines the prediction window with speech synthesizer, word prediction program may confuse the user when writing in different tenses. For example, present tense/past tense of read, when using homophones (bare/bear), or homonyms (content as verb or noun) (Tumlin & Heller, 2004). Some confusable words in English that have similar spelling (dessert, desert), or have close lexical semantics (among and between), or have inflections or case variants of the same stem (I versus me, walk/walks) may be hard for the word prediction program to isolate making the user miss the correct word (Van den Bosch, 2005). The type of task may also influence other factors such as fatigue and errors. For example, copying a task and composing a task have different demands on participants. Lack of consistent practice can also affect participant’s writing accuracy (Fazly, 2002; Thompson, 2005). Consequently, lack of concentration or experience by the writer could lead to typos.

There are varied results on use of word prediction. In some quarters, students benefit from the program but in others the effect in minimal or null. For instance, Tumlin
and Heller (2004) research showed that two of the four participants with physical
disability improved on their spelling accuracy with word prediction program while
Newell et al. (1992) research with 17 participants of varied disabilities showed improved
writing accuracy. MacArthur (1998a) also found that concurrent use of word prediction
and speech synthesizer reduced spelling errors. On the other hand, Zhang, Brooks, Frieds,
and Redelfs (1995) research with thirty-three children from grades 2-5 found that
children using ROBO-Writer produced higher quality written products and fewer spelling
errors; and the prediction lists enabled them to spell difficult words. Williams (2002) also
reported improved writing quality with participants with learning disability from an
average score of 2.78 during baseline to an average score of 3.5 with the software.
Dingleidine (2000) noted similar positive results and Hatch (2007) also found that word
prediction improved the participants’ grammar, spelling, and diction. Word prediction
was also found to increase legibility of writing when used with word processor.
Participants who used word prediction program wrote legibly compared to those who
used word processor or handwriting (Handley-More et al., 2003; MacArthur, 1998b). In
their research with a wide range of participants, Newell et al. (1992) found that word
prediction program resulted into fewer keystrokes, leading to accuracy and less fatigue.
In his research with 4-12 grade participants with learning disability, Lewis (1998) found
that participants who used word prediction wrote quality work in comparison to
participants who used the word processing, keyboarding, and alternative keyboarding
alone.
Because spelling errors come in various forms, participants who experience writing difficulty find it tricky to write or choose the correct word. However, word prediction reduces the problem when the participant uses the inbuilt dictionary (Lewis, 1998; MacArthur, 1998a, b). Magnuson and Hunnicutt (2000) categorized spelling errors into substitutions, omissions, additions, reversals, and doubling of consonants after a short vowel. Besides, he noted that punctuations add subtleties of the distinctions in sentences. For students whose work is inferior because of punctuation problems, Holdich, Holdich, and Chung (2002) recommended setting word prediction program to punctuate sentences, thus relieving them the task. Other studies have also shown improved rate of text generation when participants used word prediction (Bigelow, 2008; Lewis, 1998; MacArthur, 2000; Newell et al., 1991, 1992; Tam et al., 2002b).

Some factors that determine uses of word prediction are intrinsic; only attitudinal survey can assess participants’ attitudes to writing with word prediction. The survey can reveal the degree of device acceptability. On a 15-item scale, Lewis (1998) found that participants with learning disabilities had positive attitude toward writing. Similar results by Tumlin and Heller (2004) showed participants preferred Co:Writer to word processor alone. Two of the four participants who continued to use word prediction improved on their text entry rate. Dingedine (2000) found that word prediction increased participants’ confidence to share their written work because their written work was neat; it motivated participants to create and write more as writing became less difficult and as their anxiety reduced making them focus more on the content of their composition rather on mistakes in grammar. Dingedine argued that word prediction and speech synthesis could improve
participants’ introspection thereby reducing chances of participants dropping out of school, abusing drugs, or disrupting class programs. Mirenda et al. (2006) follow up research showed that more than two-thirds of the participants thought that Co:Writer helped them to spell better, use a wider variety of words, write faster, produce neater, easier-to-read work, and write more correct sentences. A research conducted by Williams (2002) showed increased amount of participants’ writing when word prediction program was used with speech synthesizer. She also found that participants wanted to write more and share their writing, and were eager to teach others how to use word prediction and speech synthesizer.

Although a number of studies show that participants with writing problems improved on their speed when using word prediction, in some circumstances, word prediction was slower than handwriting (MacArthur & Graham, 1987, 1997). Other studies with various participants of varied abilities also showed lower rates with word prediction (Anson, 1993; Koester & Levine, 1994a, c, 1996; Scull & Hill, 1988). Yet some studies showed no effect on the length of participants’ writing (Dingledine, 2000; Hatch, 2007; MacArthur, 1998a; Tam et al., 2002a), or no improvement on the rate of text entry (Hatch, 2007; Tam et al., 2002a). Koester and Levine (1996) found that experienced mouth-stick typists typed slower from about 20 to 12 words per minute. Lewis (1998) found the combination of word prediction and speech synthesis slowed the rate of text entry. In their research with four participants with disabilities, Tumlin and Heller (2004) found that two participants improved in typing rate, there was no change in one, and the fourth participant’s typing decreased. They concluded the key press rate,
attention, fatigue, and motor planning issues are additional factors that affect the performance of individuals with physical disabilities.

The position of the prediction window list determines the gazing and therefore the fatigue of the participant. Tam et al. (2002a) research on the location of word prediction list showed that three of the four participants preferred word prediction list in the lower middle border location, and one participant preferred it in the upper right corner. The three who preferred the prediction list in lower middle border improved in spacing and capitalization. However, a word prediction window following the cursor was not popular with the participants. Although software developers have believed that eye movements related to using word prediction list reduces when prediction list follow the cursor (Newell et al., 1992), in this research participants recorded the lowest accuracy score and lowest rates of text entry. Venkatagiri (1994) research with 21 college able-bodied students using word prediction showed that there is no difference in message preparation between a 15-word window and a 5-word window. However, lack of difference could be because of increased visual search time in a 15-word window. Venkatagiri also reasoned that the number of words displayed in the word prediction window could of had an effect on the rate of communication in a lexical prediction communication program. This is because a small number of words displayed in the prediction window are likely to omit many short, less frequently used words, since the words are likely to be completely typed out by the user before they appear.

Different studies show that word prediction program can be useful to a variety of students; those who have trouble writing and keeping to their thinking pace, those whose
rate of writing interferes with the flow of ideas, those who cannot retain ideas in their memory for long to generate a text thus interfering with the coherency, those who experience spelling difficulty, those who have motor impairment, those who use adaptive methods that slow down writing process, and those who are learning new language. Because practice improve participants’ performance, participants with writing problems should use word prediction continuously to develop their own strategies to obtain the correct word and to overcome their deficiency. Because of the disparate aggregate results, researchers should carry frequent evaluation of the use of word prediction program to ascertain its benefit.

Generally, word prediction programs have been found to increase participants’ writing independence, increase vocabularies use (MacArthur, 2000), and increase participants’ motivation to write (Hatch, 2007). However, not all programs produce the same results. Therefore, word prediction programs should be accustomed for specific user to maximize their effect (Gustavii & Pettersson, 2003). This can be done by conjuring short-term learning for the program so that it can adapt to the current text, using recency promotion so that already occurred word in the text can be given a higher probability to appear in an upcoming prediction list than before, using topic guidance to adapt the predictions to the overall subject of the current text, and making long-term learning adaptable to the user by considering both the current and previous text produced by the user. To increase the accuracy of prediction and to limit the cognitive load on the participant, word prediction should be enhanced to reject the same predicted word under the same syntactical structure (Fazly, 2002), and parameters adjusted frequently to meet
the needs of the user (Tam et al., 2002). For example, a balance between saving keystrokes and minimizing visual-cognitive loads could be achieved by using a five-word list in a vertical layout thus reducing head and eye movement (Venkatagiri, 1994). For individuals with slower visual searching abilities, Koester and Levine (1997) recommended searching the window list after typing two letters.

Statement of Problem

The lack of holistic view to examine the effectiveness of word prediction program on special needs children with writing problems has led investigators to give results of use/disuse, satisfaction/dissatisfaction based on one or two areas of evaluation. Therefore, there is need for further information on the effects of word prediction on creative writing for students who experience writing problems.

Statement of Purpose

Word prediction program is an assistive technology that predicts an entire word as each successive letter is typed thereby increasing typing speed and accuracy of learners with writing problems. This research will investigate and collect empirical data on the effect of a word prediction program on quantity and quality writing of student(s) with special needs who experience writing problems.

Research Hypotheses

Research hypothesis 1: Word prediction increases typing accuracy.

Research hypothesis 2: Word prediction increases quantity of writing.

Research hypothesis 3: Word prediction increases typing speed.
Research hypothesis 4: Word prediction increases participant’s satisfaction with writing tasks.

**Assumptions**

It was assumed that the participant was competent with keyboarding, reading, and identification of letter sounds. It was also assumed that the participant was motivated to improve his typing rate and spelling. Although the participant was told the purpose of the survey, it was assumed that his relationship with the experimenter did not influence how he answered the questionnaire.

**Delimitation**

This research was limited to data collected from total typed words and total errors during copying text and descriptive writing, and all text materials were scanned from English class reader and, plot and chapter summaries of the novels the participant was reading during his independent study. The descriptive writing topics were also tailored to participant’s interest and personal experiences. Correct word sequence was not used to evaluate the grammaticality of the sentence. Although the student was recommended reading glasses, he was not required to use them during the research because he did not have them, and therefore the experimenter could not quantify the impact of this on his visual acuity. Copying text involves reading the primary source before typing, however the participant’s reading competency was not evaluated, and therefore the impact on his visual-cognitive demand could not be quantified.
Rationale for the Research

Today, many gadgets involve inserting text into a device, such as a computer, cell phone, typewriter, augmentative and alternative communication (AAC) devices, by pressing keys on a keyboard. Apart from performing work and school assignments, computers have gained popularity as a means of communication and as a means of accessing information. Therefore, it is necessary for students with disabilities to be trained in writing and reading using computers with adaptive software when other writing interventions fail. Because use of computerized ATs enable students with disabilities perform tasks they would not minus the aids, and because word prediction program enhances cognitive skills, retention, attention, visual-motor matching, sequencing, and monitoring (Tam, Reid, Naumann, & O’Keefe, 2002b; Tumlin & Heller, 2004) for student with writing problems, all effort must be taken to eliminate causal factors that contribute to academic failures. As Williams (2002) observed, word prediction can be used in conjunction with programs other than a word processor to perform various tasks. For example, to plan a paper or respond to a class, students can create a graphic organizer using Co:Writer with the Inspiration software. Venkatagiri (1994) noted that word prediction is one of the most common communication acceleration techniques employed in the microprocessor based communication programs. Because word processing tools include text-entry tools such as word prediction, speech synthesis, and editing tools such as spelling and grammar tools, and because of rapid technological changes and because of different word prediction programs having different features, there is need for frequent
evaluation of the effect of these ATs, including word prediction, to ascertain their efficacy.
Chapter 2: Method

This chapter deals with methodology: participant, setting, researcher, materials, experimental design, dependent and independent variables, response measurement and interobserver agreement, procedures, procedural integrity, and social validity.

Participant

The participant was 15-year-old African American male sophomore at a local high school. He lived with a foster family. He was on individualized education program (IEP). His IEP goal was to graduate high school. His IEP also showed that he did not have limited English proficiency or visual impairment or was in need of assistive technology devices and/or services or specially designed physical education. He did not have a behavior that impeded his learning or the learning of others. However, the IEP indicated he had communication needs. His results on the Woodcock-Johnson Tests of Achievement III in 2008 showed that his reading achievement fell within the average range to well below average range of his age group. His performance fell within the average range on a task requiring him to read and comprehend short paragraphs. In contrast, his performance fell within the well below average range on a task requiring him to decode a series of words as well as on separate tasks requiring read simple sentences and respond either “yes” or “no”. His decoding skills were inconsistent. His
communication skills included articulation errors, grammar errors, but he had average range receptive and expressive language skills overall. The 2008 evaluation showed his Working Memory skills fell in the Lower Extreme range. As such, he needed additional explanations, repetition of information, breaking of information into steps or completion of pieces at a time, provision of examples, and hands-on demonstrations to understand fully the meaning of content. In 2005, the participant was diagnosed with Attention Deficit Disorder, Post-Traumatic Stress Disorder and mild depression. Although eyeglasses were prescribed, he never wore them. The IEP also indicated that he was an inquisitive and social student, behaviors his English teacher approved. He was considered for the study because he volunteered. He also experienced writing problems with spellings and writing at length and his rate of text generation was below 20 wpm with word processor. The experimenter sought the guardian’s permission and participant’s assent before starting the study.

**Setting**

The classroom was partitioned into two: the main room where learning/teaching takes place and the teacher’s wall-glassed closet. The research was conducted inside the teacher’s closet away from distraction. The closet had good ventilation and lighting, and spacious for four people. The teacher’s closet was noise proof but transparent. It had lockable door. There was a carpet on the floor. The main class had seven tables, twelve chairs, one dry-erase board, a brown chalk board, notice boards, pencil sharpener, three computers, a radio cassette, a Video Compact Disc, Television set, a projector, a cabinet,
three shelves with students’ files, class textbooks, stationery, a sink, coffee maker, and utensils. The closet had two tables, a cabinet, and a shelf stacked with books.

**Experimenter**

The experimenter was a master’s student in Special Education program and had bachelor’s degree in general education and special education. He had completed all course work by the time of this research.

**Materials and Equipment**

The following materials and equipment were used in the study: *Dell* laptop, *Co:Writer* program, flash drive, stop watch, data score sheets, Interobserver sheets, scanner, task analysis, *Touching Spirit Bear* by Ben Mikaelsen, *Among the Hidden* by Margaret Peterson Haddix, and *Left Behind* by Tim LaHaye. The experimenter provided the computer and word prediction software. The writing output was saved to a USB flash drive, printed and a copy retained by the experimenter.

**Definition and Measurement of Dependent Variables**

The total typed words, the rate, and number of spelling errors were the dependent variables. Total typed words (TTW) were defined as the number of words typed including the errors. The rate was defined as the number of total typed words divided by time. Total typing time was calculated by subtracting starting time from stopping time. 29 seconds and below were rounded to a whole number down (4.29 minutes = 4 minutes) and 30 seconds and above were rounded to a whole number above (example, 3.30 = 4 minutes). (A word was operationally defined as one or more letters separated by either a space or a punctuation mark, and a spelling error was defined as forming of word by a
letter or letters in an unaccepted order. Errors were considered when a letter or word was duplicated (increasing letter twofold, for example, *fix fix*); added (adding unnecessary letter to a word, for example, *ther for the*); omitted (omission of a letter or letters in a word, for example, *imense for immense*); transposed (changing of the order or arrangement of a word, for example, *hwole for whole*); separated (inserting a space into a compound word, for example, *mean while for meanwhile*); split (created unnecessary space between a word, for example, *sudden ly for suddenly*). Errors were also considered when there was a substitution of a letter (putting one letter into another, for example, *apload for upload, boi for boy*), or substitution of a word (switching seemingly equivalent words, for example, *lad for boy*). All short forms, except commonly used abbreviations were considered errors. For example, *NY for New York, OH for Ohio, e.g., Mr., Mrs.*, were considered correct whereas *MLK for milk, omg for oh my gosh* were considered incorrect. When an error was consistent, it was counted as one, for example, if the participant wrote *mountan, mountan* for mountain. However, when a misspelling was written in different ways, it was counted as different spelling errors, for example, *mountan, mountin, mounten*. To get the total correct words, the experimenter subtracted total errors (TE) from total typed words (TTW). Total typed words were calculated by summing the number of correct words plus the number of incorrect words.

**Independent Variable**

The word prediction program, *Co:Writer*, was the independent variable. To avoid technical problems that might arise because of orthographical differences between the different dialects of English, the Co-PI ascertained the participant used American
English. In the intervention phase, the participant used a word processor with the word prediction program. When the participant failed to use Co:Writer during the intervention phase, the experimenter provided a verbal prompt to use it. The experimenter recorded total typed words and total spelling errors at the end of each session.

**Experimental Design**

The experimenter used a single-subject, A-B-A-B design across tasks to determine the effect of word prediction on quantity of writing. The research included training, baseline, and treatment. The participant automatically alternated the use of word processor and word prediction after five successive sessions, except in training phase that took three days after skill mastery and baseline A2 four days because of school closure.

**Response Measurement and Interobserver Agreement (IOA)**

*Inter-rater reliability.* The participant had 20 minutes to write both part 1 and 2 of the tasks, two minutes transition between tasks, and two minutes of prompts. The IOA was scored on permanent products. To eliminate influence of a trend, the IOA observer scored permanent products that were coded by the experimenter; the IOA observer could not tell the order when they were typed.

*Sensitivity.* The graphs were visually analyzed to detect any differences in levels and trends between conditions (Kazdin, 1982) and to check for experimental control (Barlow & Hersen, 1984).

*Data Analysis.* To determine the effect of word prediction on the quantity of the participant’s typing, the experimenter graphically displayed the results and visually analyzed data for level of change, slope change, and variability in baseline and treatment.
**Accuracy.** The experimenter used direct measurement and a stopwatch to note the starting and stopping times. The observer and experimenter were seated two feet from the participant and two feet from one another. From two feet the experimenter could see whether the participant was using the *Co:Writer* appropriately. This also allowed for quick response when the participant needed clarification or when *Co:Writer* developed a problem. The permanent products were scored using accuracy percentage – which is simply the number of words the participant got right compared to how many he typed. For instance, 90% accuracy meant he averaged 66 out of 73 words right.

**Validity.** For validity, the IOA observer rescored the texts following the scoring rubrics established by the experimenter. Because two variables (total typed words and spelling errors) were measured, the newly scored text was not scored immediately to minimize observer drift. Furthermore, the IOA observer used the same procedure to score the total typed words, the total errors, and the total correct words by reading and counting typed words and by using *Microsoft Word 2007*. The participant’s paragraphs were analyzed for spelling errors and total words typed (Hasbrouck, Tindal, & Parker, 1994) to detect the correlation and trend of the two. Besides, the threats to internal validity were minimized by selecting a participant who had never used word prediction program but had some experience with keyboarding. During descriptive writing, the experimenter prompted the participant on the writing topic. The prompts goal was to reduce/eliminate testing recall knowledge from memory. To avoid regression the observer introduced reinforcement in the form of praise during the intervention phase. To avoid the threat of maturation, the research lasted only four weeks. All the testing used *Co:Writer*. 
Procedures

*Training Phase.* The experimenter conducted the training in an office away from distractions. He modeled text input, first by typing a sentence with word processor alone, second by typing a sentence with word processor and *Co:Writer*. For example, *Two men accompanied Cole in this final leg of his journey.* The experimenter then physically guided the participant on the most convenient way to insert text by using keyboard, word processor, and word processor with word prediction, *Co:Writer*. The participant then copied a sentence by typing it on the computer using the word processor alone, then with word processor and *Co:Writer*. The experimenter signaled the participant to start typing by saying, “Begin.” This was to reduce time latency. Immediately, the experimenter started the stopwatch and stopped at 10 minutes or when the participant typed the last letter/punctuation. The participant was considered to have mastered the prompts when he started writing within one minute after the first prompt (“Begin”), for at least five consecutive times. A second prompt (“Begin”) was given when the participant did not start writing for another five seconds after one minute. When he wrote less than three sentences or when he wrote for less than two minutes, the time taken, total typed words, and total errors were recorded. During training, the experimenter recorded the TTW and total errors (TE) when the participant used word processor with word prediction.

The experimenter explained to the participant characteristics of descriptive writing as a prose that delineates—shows the form or outline of a person, activity, thing, place, event, feeling, or scene. The participant was told the goal of a descriptive writing was to type in prose what ones thinks, in such a way that the reader feels as if he were not
reading it but watching it live or experiencing it himself. The experimenter used short sentences. This made the participant concentrate on learning to use the program. During the training, the experimenter pointed at the appropriate word in the window list and appropriate keypad. The participant was trained on the most convenient way to insert text by using keyboard and cursor, word processor, and word processor with word prediction. The participant was considered to have learned the word prediction strategy when he used both word processor and word processor with word prediction with at least 95% accuracy, choosing the appropriate word when typing the given sentences.

The training was conducted for three days, taking a total of one and a half hours, with each session lasting 30 minutes. The participant copied grade-level paragraphs taken from class English reader, Touching Spirit Bear by Ben Mikaelsen, and from plot and chapter summaries of Among the Hidden by Margaret Peterson Haddix. The randomly chosen passage was displayed on the top-right side of the screen. To minimize training time, the experimenter set the features of Co:Writer to the following: (a) display - word window instead of sentence or paragraph window, five word guesses in the window arranged dynamically and vertically instead of fixed or horizontally, single-spaced instead of double spaced or best guesses first or alphabetical guesses, Arial text font at size 14, set colors harmonized for clear visibility – background- light green, text color-black, cursor color- red; (b) prediction – flexible spelling in which a words appeared after typing two letters instead of always or exact spelling only, guesses appeared as always instead as needed. In addition, the following features were unchecked: repeat guesses, predict in-line, and predict ahead, double space after sentence. On the other hand, the
following features were checked, auto-hide, grammar, auto-caps, single space after word, smart punctuation; (c) speech was activated such that words were read when highlighted by pointing by mouse or arrows keys or scanning or after punctuation or hitting spacebar. The speech synthesizer automatically said accepted word and finished sentence instead of in-line prediction speech and reading of each letter. A woman’s voice – laura 22s with speech rate 85 and volume 50 was used because it was less mechanical. Other checked boxes included speak descriptions, scanning options (scan words automatically, scan in a loop), and scan rate at 7 on a scale of 1-10, and delay before scan at 1 on a scale of 1-10. The participant was taught to type two letters then look at the word prediction list. As Koester and Levine (1998) noted this two-letters-then-search strategy balance visual-cognitive demands and keystroke savings for individuals with slow visual scanning abilities. This in turn reduces the rate of fatigue. The word prediction list was limited to five words to decrease cognitive load. The speech synthesis option was activated to increase chances of noting a mistake after typing a word and after typing a complete sentence. The experimenter saved the written output on both the computer and USB flash drive, and printed a copy (a permanent product) for easy and reliable scoring.

**Intervention Phase**

*Baseline.* The experimenter started testing after the participant had mastered use of word prediction. The baseline sessions were divided into two parts: copying text and descriptive writing. In part one, the participant copied a grade level text without word prediction. In part two, the participant wrote a descriptive paragraph without word prediction. The experimenter signaled the participant to start typing by saying, “Begin.”
Immediately, the experimenter started the stopwatch and stopped at 10 minutes or when the participant typed the last letter/punctuation. When the participant requested help with the spelling (when using word processor alone), he was told to spell the word to the best of his ability. The participant was given a new, at grade level passage every session and was asked to copy it as quickly and accurately as possible. The text copied ranged between 70 and 80 words. He had ten minutes for each part, two minutes for transition, and two minutes for prompting.

Treatment. The treatment sessions were divided into two parts – copying text and descriptive writing. In part one, the participant copied a grade level text with word prediction. In part two, the participant wrote a descriptive paragraph with word prediction. The experimenter signaled the participant to start typing by saying, “Begin.”

Immediately, the experimenter started the stopwatch and stopped at 10 minutes or when the participant typed the last letter/punctuation. When the participant requested help with the spelling (when using word processor and word prediction), he was told to choose the appropriate word from the prediction window list. The participant also received assistance when word prediction developed problems and when he had difficulty with the operation of the word processor or word prediction (e.g., precision with the cursor, inserting text, differentiating punctuation marks).

Procedural Integrity

To ensure procedural integrity, the participant was trained (a) to use a word processor alone, and (b) a word processor with word prediction. The participant was considered to have mastered the use of word prediction program when he consistently
used it for the completion of five sentences with an average of ten words per sentence without the experimenter giving verbal prompts. The experimenter used task analysis (see Appendix J) and followed the underlain procedures to control for implementation confounds. During treatment, he ensured the participant used the word prediction to select the appropriate word from the window list. The multiple treatment interference was checked by using an A-B-A-B design and alternating the tasks from session fourteen (alternating copying text and descriptive writing).

However the experimenter could not collect data three of the planned sessions, first when the school was closed after a burst of the water pipes, second when the participant attended a transition orientation program in Delaware, and third when the classes were cancelled because of parents-teachers meeting. Instead, the sessions were pushed forward.

**Social Validity**

Assessing social acceptability of the intervention procedures and device use is important in determining its continued use beyond the research; its acceptability by the students, parents, teachers, and other interventionists. Therefore, the participant was given a questionnaire about the research. From the questionnaire, the participant was satisfied with the training and noted that it was easy to use Co:Writer. He also noted that Co:Writer improved his spelling accuracy, reduced his errors, and that it increased the time he spent writing, he also felt confident to write with Co:Writer and would use it again because he is sure of selecting appropriate word from the window list. However, he noted that Co:Writer reduced his typing rate because he had to look at the main text and
the predicted words, and that changing eye positions was taxing and interfered with his flow of thoughts. Although he noted that he would advise his friends who experience writing problems to use it, he thought that students who type very fast might not benefit from word prediction.
Chapter 3. Results

This chapter analyses the use of word prediction in copying text and in descriptive writing: The total typed words and total errors, accuracy percentage, and rate of typing. The chapter also includes data for interobserver agreement (IOA).

Interobserver Agreement

In the IOA for the performance data, the IOA observer randomly selected paragraphs across tasks for 26% of the sessions and independently counted the total typed words and total spelling errors. The IOA was calculated using occurrence (scored interval) agreement formula: dividing the number of agreements occurrence (A) by number of agreements occurrence (A) plus the number of disagreements occurrence (D) times 100, which was 80%. Appendix G shows summary of IOA results for the scored permanent products.

Research Hypothesis 1: Word prediction increases quantity of writing.

The participant either typed the exact number of words, or typed one less, or one more during each trial. Total typed words were less by one word when the he omitted a word. Total typed words were more when he divided a compound word. Table 3.1 shows the performance data. The copied text had 70 – 80 words, while in descriptive writing the total typed words ranged from 46 –119 words. In copying text, combined means for total
typed words were similar, baselines 75.78 and treatments 75.40. In copying text, the mean errors across sessions were slightly different, baselines 3.33 and treatments 2.7. In descriptive writing, the combined means for total typed words was slightly different, baselines 89.89 and treatments 77.80. In descriptive writing, the mean errors were more different, baselines 9.22 and treatments 6.10. Table 3.2 summarizes comparison of performance across sessions across tasks. Table 3.3 summarizes means across sessions across tasks. Figure 3.1 compares total typed words and total errors across sessions during copying text. Figure 3.2 compares total typed words and total errors across sessions during descriptive writing.
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<th>Session</th>
<th>Copying Text</th>
<th>Descriptive Writing</th>
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<td></td>
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<td>73</td>
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<tr>
<td></td>
<td>22 78</td>
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</table>

Table 3.1. Performance data.
<table>
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<tr>
<th></th>
<th>Copying Text</th>
<th>Descriptive Writing</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Baseline</td>
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</tr>
<tr>
<td>TTW Mean (SD)</td>
<td>682 (3.87)</td>
<td>809 (15.6)</td>
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<tr>
<td>TE Mean (SD)</td>
<td>30 (2.6)</td>
<td>83 (2.5)</td>
</tr>
<tr>
<td></td>
<td>Treatment</td>
<td></td>
</tr>
<tr>
<td>TTW Mean (SD)</td>
<td>754 (3.2)</td>
<td>778 (16.0)</td>
</tr>
<tr>
<td>TE Mean (SD)</td>
<td>27 (2.0)</td>
<td>61 (3.7)</td>
</tr>
</tbody>
</table>

*Note: TTW: Total typed words. TE: Total errors.*

Table 3.2. Comparison of performances across sessions across tasks.
<table>
<thead>
<tr>
<th>Tasks</th>
<th>Sessions</th>
<th>Mean</th>
<th>TTW</th>
<th>TE</th>
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<td>A</td>
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<td>B</td>
<td>74.6</td>
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</tr>
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<td>A</td>
<td>78.7</td>
<td>2.5</td>
<td></td>
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<tr>
<td></td>
<td>B</td>
<td>76.2</td>
<td>3.0</td>
<td></td>
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<td>Descriptive Writing</td>
<td>Training</td>
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<td>3.7</td>
<td></td>
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<td>7.6</td>
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<td>71.2</td>
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<tr>
<td></td>
<td>A</td>
<td>95.5</td>
<td>11.3</td>
<td></td>
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<tr>
<td></td>
<td>B</td>
<td>84.4</td>
<td>7.6</td>
<td></td>
</tr>
</tbody>
</table>

Table 3.3. Means across sessions across tasks.
Figure 3.1. The total typed words and total errors made during training, baseline, and treatment when participant copied text.
Figure 3.2. The total typed words and total errors made during training, baseline, and treatment when participant wrote descriptive paragraph.
Research Hypothesis 2: Word prediction increases typing accuracy

Figure 3.3 shows the participant’s accuracy percentage in copying text during training, baselines 1 and 2 and treatments 1 and 2. The participant copying of text in training phase varied between 95-98%. In baseline 1, the accuracy percentage varied between 90-100%. In baseline 2, the accuracy percentage varied between 96-99%. In treatment 1, the accuracy percentage varied between 94-99% and in treatment 2, it varied between 90-100%.

Figure 3.4 shows the participant’s accuracy percentage descriptive writing across with and without word prediction during training, baselines 1 and 2 and treatments 1 and 2. During training the participant accuracy percentage ranged 93-95%. In baseline 1, the accuracy percentage ranged 89-92% and in baseline 2, 89-91%. In treatment 1, the accuracy percentage ranged 85-99% and 88-94 in treatment 2. Table 3.4 shows summary of accuracy percentage.
Figure 3.3. The accuracy percentage of copying text with and without word prediction.
Figure 3.4. The accuracy percentage of descriptive writing with and without word prediction.
<table>
<thead>
<tr>
<th>Sessions</th>
<th>Copying Text</th>
<th></th>
<th>Descriptive Writing</th>
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Table 3.4. Accuracy percentage data.
**Research Hypothesis 3: Word prediction increases typing speed.**

The participant-typing speed varied across sessions across tasks. During training, the participant remarkably improved on typing using word prediction. In copying text, compared across sessions, the rate of typing and variability was relatively higher during baselines than during treatment, mean 11.2 wpm during treatments, mean 10.47 wpm during treatment. Similarly, in descriptive writing, compared across sessions, the rate of typing and variability was relatively higher during baselines than during treatment, mean 16.2 wpm than during treatments, mean 14.74 wpm. Figure 3.5 shows the rate of copying text with and without word prediction. Figure 3.6 shows the rate of typing with and without word prediction during descriptive writing. Table 3.5 shows rate of typing across conditions.
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<thead>
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<th>Sessions</th>
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Table 3.5 Rate of typing across sessions across tasks.
Figure 3.5. The rate of copying text during training, baselines 1 and 2, and treatments 1 and 2.
Figure 3.6. The rate of descriptive writing during training, baselines 1 and 2, and treatments 1 and 2.
Research Hypothesis 4: Word prediction increases participant’s satisfaction with writing tasks.

A Likert-type scale questionnaire with twelve questions was used to evaluate the participant’s satisfaction with word prediction, on a scale of 1-5, with 1 indicating “Strongly disagree/Not at all/Very unlikely” and 5 being “Strongly agree/Very/Very likely.” A neutral response was also available. Thus, the scale had a range of 0 to 60 points. His score was 40 points. The participant “strongly agreed” in five questions, “agreed” in three questions, was “undecided” in one question, and “disagreed” in one question. He was very satisfied with the training and that he liked the procedures (all answers were 5). He disagreed that word prediction made him write more, he was undecided if word prediction improved his confidence when typing, but he agreed that his spelling improved, and that he spent more time writing (all had a score of 2). He strongly agreed that his spelling errors reduced. He noted “very likely” that he would use word prediction when emailing. He noted that using word prediction was easy and he liked using it and that he would use it again. He also noted that he would recommend word prediction to other students who experience writing problems.
Chapter 4. Discussion

In this chapter, the experimenter discusses the results of the research questions by relating them to previous research, and he discusses the limitations of the study and makes recommendations and directions for future research.

**Research Hypothesis 1: Word prediction increases quantity of writing.**

When compared across sessions and across tasks, the total typed words differed markedly. The participant copied the exact total number of words, typed one less, or typed one more. The copied text had 70 – 80 words. In descriptive writing the total typed words ranged 46 – 119 words. In copying text, combined means for total typed words were similar, baselines 75.78 and treatments 75.40. Moreover, the mean errors across sessions were slightly lower, baselines 3.33 and treatments 2.7. Although the mean quantity of copying text was similar, the mean error in the combined treatment phases was lower, suggesting that word prediction improved his writing accuracy. Possibly *Co:Writer's* over 35,000 root words helped the participant choose appropriate words.

However, in descriptive writing, the combined means for total typed words was slightly lower, combined baseline phases was 89.89 and combined treatment phases was 77.80. On the other hand, the combined mean errors dropped markedly, baseline phases
9.22 and treatment phases 6.10. The participant’s total typed words without word prediction were more compared to total typed words with word prediction.

The participant typed fewer words with word prediction than with word processor alone. Possibly, because word-prediction-window list failed to predict appropriate words (when the participant typed the wrong initial letters), making the participant spend more time figuring out the appropriate word. In other situations, he would type very fast only to look at the correct word in the window list afterward. This happened mostly with short words, such as *it*.

The speech synthesizer might have also increased the participant’s cognitive load when it mispronounced misspelled words. According to Newell et al. (1992), different students respond to the use of word prediction features differently and this affects the total number of typed words and spelling errors. These individual differences affect the writer’s attention to the spelling of each word, and the concentration, identification, and selection of the correct word, which could interfere with typing speed and coherency of thought. Therefore, typing correct initial letters is crucial for appropriate word prediction or word prediction predicts the wrong words, which results in a delay in predicting or failing to predict the correct word (MacArthur, 1999a, b). The experimenter also noted the participant was anxious when using word prediction, it made him focus more on the chosen word at the expense of typing.

During descriptive writing, the student either chose a topic from a list of prewritten topics or came up with an impromptu topic that he was comfortable writing about. When the participant was undecided for a minute, the experimenter decided on one
topic after conferring with him, to reduce the impact of comprehension and burden of recalling points. He typed familiar words faster than he typed unfamiliar words, but he spent more time figuring out misspelled words. These spelling errors could explain why his typing time across sessions averaged five minutes when he had been allocated ten minutes each for both tasks. A number of researchers (e.g., Bigelow, 2008; Montgomery & Marks, 2006; Williams, 2002) have attributed this to difficulty in piecing enough relevant ideas together for describing, exposting, or persuading a particular audience. Applebee and Langer (2006) noted that although students who experience writing problems exhibit different characteristics, they generally avoid writing comprehensively by either leaving out important points in their essays or failing to develop their points persuasively.

**Research Hypothesis 2: Word prediction increases typing accuracy.**

There is no standard method of calculating words per minute (wpm). Some researchers use a corrected score while others just note the errors. MacArthur (1998b) calculated typing speed (wpm) by dividing the number of words (counting four nonspace characters as a word) by total minutes. Tam et al. (2002a) calculated “[t]he number of correct keystrokes by subtracting the number of errors from the total number of keystrokes.” He then counted five keystrokes as one word. Each of his study sessions lasted five minutes. To get the rate of text entry, he divided the “total number of correct keystrokes” by the time taken. The percentage accuracy was then calculated by dividing the number of correct keystrokes by the total number of keystrokes, multiplied by 100. On the other hand, Handley-More et al. (2003) defined total typed words as:
The total number of words produced and was determined by dividing the number of characters written by 5. A character was defined as a letter, number, punctuation mark, symbol, or space. Work that had been deleted or erased from the story was not counted. This formula was used because it allowed accurate comparison between stories regardless of the length of the words used. In addition, UltraKey 3.0 (1995), Microsoft Word 5.0 (1991) and Microsoft Word 5.1 (1992) defined one word as five keystrokes for their words per minute or word count calculations.

In this study however, the experimenter used accuracy percentage – which is simply the number of words the participant typed correctly compared to how many he typed multiplied by 100. This took care of the variability in the lengths of copied text and total typed words in descriptive writing.

The results of copying text across sessions across tasks did not differ markedly. His accuracy percentage ranged 95-98% during training, 90-100% during baseline 1, and 96-99% during baseline 2. During treatment phases, the accuracy percentage also varied 94-99% during treatment 1 and 90-100% during treatment 2. He had high accuracy percentage variability during descriptive writing with a range of 85-99% during treatment 1 and 88-94% during treatment 2 (See Table 3.4, above.) Venkatagiri (1994) reasoned that a small number of words displayed in the prediction window are likely to omit many short, less frequently used words, since the words are likely to be completely typed out by the user before they appear. Although the speech synthesizer had a relatively natural voice, having it on produced only a small difference on participant mean errors with and
without word prediction across different tasks. Possibly the participant did not benefit much from the speech synthesizer because his typing was relatively fast compared to the rate the speech synthesizer identified the words and uttered them. Although he typed familiar words quickly, but he spent on average thirty seconds figuring out a misspelled word. Thus, the participant’s use of Co:Writer did not significantly decrease spelling errors across conditions. Lewis (1998) hypothesized that students in high school may not gain from the use of word prediction. MacArthur (1998b, 1999) observed that some students fail to attend to the list of predicted words or fail to select a correctly predicted word, and that writing ability alone cannot explain the difference. He also found that not all students benefited from word prediction, and that motivation probably plays a role in how the students use word prediction.

Software developers have believed that visual-cognitive effort reduces when the prediction list follows the cursor (Newell et al., 1992). In this research, however the participant recorded the lowest accuracy score and lowest rates of text entry with word prediction.

He made various errors. Substitution and omission consisted of the most errors. He omitted mostly a letter, for example, disapering (disappearing), buglary (burglary), aportion (apportion). He wrote most of the substituted words almost phonetically. For example, hin (him), eals (heals), jone (gone), cuver (cover), humen (human), insans (insane). Most of the words he transposed indicated he knew the spellings, but because he probably typed faster than the word prediction program could predict, he failed to realize the misspellings. At the same time, a number of the errors were short words. For
example, *fuor* (four), *ti* (it), *calw* (claw), *pepole* (people), and *paly* (play). Possibly an effect of typing very fast. For example, *speack* (speak), *whent* (went). He also added unnecessary letters to words, for example, *animale* (animal), *buul* (bull), and *parenst* (parents). He doubled some consonants after the vowel. For example, *actuall* (actual), *sometimething* (something), and *pille* (pile). In some cases, he split compound words. For example, *every thing* (everything), *your self* (yourself), *mean while* (meanwhile). He also used some of the letters that look similar when inverted. For example, *burng* (during), *disodeyed* (disobeyed). He separated a letter from a word, for example, *a bout* (about), and combined others for example, *itcan* (it can), *allday* (all day). He made consistent errors with some words, such as *whent* (went), and inconsistent errors with others such as, *mountan*, *mounten*, *mountin*, *mountans*, *mountens* (See Appendix H). However, he did not make abbreviation errors. George Cleveland Kyte identified causes of errors as “carelessness, mispronunciation, phonetic errors, homonym confusion and writing errors” (as cited in Clement, 1971, p. 9).

Although the participant’s IEP report indicted his writing skills fell in the average range, the results of this study show that he had problems writing longer words. This may have frustrated him making him and contributing to not writing at length. The patterns of spelling errors also showed that the participant likely checked the misspellings at the end of typing a word. MacArthur (1998b, 1999) observed that some users prefer to check spelling at the end of typing a word whereas others keep track of a word as they type. The participant seemed not to have gained in accuracy using word prediction; he made more errors with long words than with short words, possibly because long words need more
initial letters for precise prediction. At the same time, as it was noted in his IEP report, his African American colloquialisms and pronunciation may have influenced his listening to a speech synthesizer, thus failing to choose appropriate word.

**Research Hypothesis 3: Word prediction increases typing speed.**

Use of word prediction depends on many factors: correctly typing the initial letters, scanning the window list, selecting appropriate word, inserting the word by clicking on it by mouse or by pressing the number on the keyboard. The sequence involves visual-cognitive-motor coordination (Newell et al., 1991; Newell et al., 1992; Tam et al., 2002a). To decrease cognitive load, the word prediction list was limited to five words. As Venkatagiri (1994) noted, a balance between saving keystrokes and minimizing visual-cognitive loads could be achieved by using a five-word list in a vertical layout, thus reducing head and eye movement.

Although the participant often used school computers, his rate of typing varied across sessions across tasks. In copying text, compared across sessions, the rate of typing was relatively higher during baseline phases than during treatment phases (combined baseline mean 11.2 wpm, combined treatment mean 10.47 wpm). Similarly, in descriptive writing, compared across sessions, the rate of typing was relatively higher during baseline phases than during treatment phases, combined baseline mean 16.9 wpm combined treatment mean 14.74 wpm. During treatment phases, the speech synthesis option was activated to increase chances of noting a mistake after typing a word and after typing a complete sentence. However, it might have increased the participant’s cognitive
load when it pronounced misspelled words. The speech synthesizer also has a mechanical voice. This may be unpleasant to the ear.

Although the speech synthesizer was on, the participant found it distracting because it would read a word when he was already typing a new word. He used the cursor occasionally to listen to word in the prediction window and when it mispronounced the word he would sigh. As such it could not help the participant discriminate homonyms (e.g., desert [leave] and desert [arid region], to/too/two) and homophones (e.g., their and there, though and how [sic]). Typing numbers and hyphenated words, such as well being (well-being), twelveyearold (twelve-year-old) was also difficult. On the other hand, word prediction made typing compound and hyphenated adjectives difficult. This made the participant spend more time figuring out the appropriate word. Considering the participant’s typing time averaged five minutes throughout the study, we can conclude that typing accuracy affects quantity of typing. Lewis (1998) found that students rate of text production reduced when the speech synthesizer was on. He also theorized that high school students with learning disabilities might benefit least with word prediction.

**Research Hypothesis 4:** Word prediction increases participant’s satisfaction with writing tasks.

Assistive technology and computers have made it possible for students with writing problems to be integrated in various writing processes. Advanced compatible programs have made working on computers more interesting especially for students who abhorred writing (Becker, 1999; Hatch, 2007; Lewis, 1998; MacArthur & Graham, 1987, 1997; Tumlin & Heller, 2004; Zhang, et al., 1995).
Word prediction, such as *Co:Writer* can now be installed in school computers for students’ use. However, the type of word prediction program and individual differences determine its performance (Newell, et. al., 1992; Obringer et al., 2007). Therefore, software evaluation is necessary to determine efficiency and effectiveness. A Likert-type scale questionnaire with twelve questions was used to evaluate the participant’s satisfaction with word prediction, on a scale of 1-5, with 1 indicating “Strongly disagree/Not at all/Very unlikely” and 5 being “Strongly agree/Very/Very likely.” A neutral response was also available. (see Appendix M). The participant’s satisfaction with word prediction varied.

He agreed that he liked using word prediction and that he would use it again (mean = 5). He also indicated he was satisfied with the training and procedures, and that he would recommend it to needy students. However, he disagreed with five questions that word prediction helped him with reduction of errors or improvement of spellings, increment of total typed words and time spent typing (mean = 2). He wrote that he “really liked using the *Co:Writer*.” Possibly his liking of the word prediction program was because it was the first time he used it. But he might have considered it having had no impact on his total typed words. A number of research studies have also noted students’ positive attitude toward use of word prediction (Dingledine, 2000; Lewis, 1998; Mirenda et al., 2006; Tumlin & Heller, 2004).

**Implications**

Use of computers in schools has made it easy for students and teachers to address different writing problems. However, the continual software changes and computer
changes may have made word prediction difficult or obsolete on specific computers. Because of these, setting word prediction on computers may need to be continuously observed, limiting the student’s independence to work. As such, word prediction alone cannot teach students proper writing mechanisms. Until computers are compatible with software, teachers should be considering teaching students appropriate writing skills.

**Limitations of the Research**

This research focused on the effect of word prediction on total typed words, rate of typing, and total spelling errors. A word was considered a letter or combination of letters that make a sensible word, and not a combination of five characters (Handley-More et al., 2003). As such, the syntax was not considered when counting errors. Second, because the copied text had between 70-80 words, the text variability might have influenced the time of copying text and number of errors. On the other hand, different word prediction programs have unique operational system that influence user interface. Besides, individual differences play a major role in user interface (Wester, 2006). The participant used a *Dell* laptop whereas in the school he used desktops. Considering that the laptop keyboard is compact and that some keys are arranged differently from a desktop keyboard, it may be unclear the impact of different keyboard layout had on his typing rate or accuracy. As such, these results with *Co:Writer* may not be generalized across students and across programs.

From session four to session thirteen, the participant copied texts before writing descriptive paragraphs. From session fourteen however, he started with descriptive writing and ended with copying text. He was also prompted before descriptive writing. It
may not be clear if a longer study would have affected his writing competency considering that training alone happened in three days. Laffont et al. (2007) noted that students might need a long training period to master using word prediction.

Whenever a participant does more than one task in a different condition, there is a possibility of carryover effects, in this research the carryover effect was checked by having the descriptive writing not directly related to copying text. However, the experimenter cannot rule out the influence of the past-experience of doing a task has on doing the same task again.

In this study, the experimenter provided the computer and word prediction program. That means using software on a school computer may be difficult. Other school computers may not be compatible with a specific program. Therefore, school policy on ATs should be considered because not all computers can be loaded with word prediction software.

**Suggestions for Future Research**

The student in this study did not have an increase in typing rate or accuracy or total typed words with word prediction. Therefore, future studies should seek to identify who would benefit from using word prediction software. Although it would take substantial time, it would be interesting to have the participant select the features of *Co:Writer* before any study. Although this would require more familiarity with the program and, thus, more training. Future research should involve more participants writing different categories of creative writing: analytic, persuasive, descriptive, augmentative, cause and effect, exploratory, definitive, expository, deductive, and
critical. Future research should also focus on the impact of the speech synthesizer. On the other hand, the spelling errors were considered in isolation, therefore future research should focus on the quality of writing (pragmatics, syntax, semantics) of the written sentences.

From session four to session fourteen, the participant wrote descriptive paragraphs after copying text. However, from session 14, he started by typing a descriptive paragraph. This was to check carryover effects. However, in this design the carryover effect was still possible considering the short transition time (1-2 minutes). The second task performed may have been performed better because of practice effect or because participant had become primed to copying. Alternatively, the second task performed may have been performed worse because participant had become tired or bored. To avoid participant practice effect or decay rate, future research should focus on one task. In addition, the copied text should be of the same length to reduce effect of variability.

Conclusions

The integration of computers as a teaching aid has increased their use in schools and today many students use word processors, CD ROMS, and the Internet (Becker, 1999) to do assignments, to socialize, or to play games. For some students whose writing problems interfere with generation of ideas and writing accuracy, word predictors may assist with spelling and increasing vocabulary, ultimately helping students improve their writing competency, but this was not true for the student in this study. In choosing word prediction, individual differences should be the criteria because not all students benefit
from a device (Fazly, 2002). Possibly the degree of disability, keyboard competency, rate of typing, word prediction settings, should guide experimenters in choosing word prediction.
References


Dingleline, A. (2000). Effects of speech synthesis and word prediction software programs on the attitudes and writing skills of participants with special needs (Masters dissertation, Urbana University, 2000). *THE: EDU 2000 MS .D563*


66


APPENDIX A: GLOSSARY OF TERMS
A—Baseline: The sessions during the study when the participant used word processor alone.

A occurrence — Agree occurrence: An instance when the experimenter and observer concurred of writing happening.

AT— Assistive technology: Devices for people with disabilities and includes the process used in selecting, locating, and using them.

B—Treatment: The sessions during the study when the participant used word processor and word prediction.

Co-PI— Co-Principal Investigator: Co-PI herein referred to as experimenter was the individual involved with the principal investigator in the scientific development or execution of the study. He devoted 100% of time to the study.

D occurrence—Disagree occurrence: An instance when the experimenter and observer differed of writing happening.

IOA— Interobserver agreement: A method used to evaluate inconsistencies in findings from different evaluators who collect the same / similar information.

T— Transition time: A period when the participant changed from copying text to descriptive writing or vice versa.

IEP—Individualized Educational Program: A plan designed to meet the unique educational needs of a student.
APPENDIX B: ABBREVIATIONS
SD— Standard Deviation
SMS— Short Message Service
TCW— Total Correct Words
TE— Total Error
TTW— Total Typed Words
USB— Universal Serial Bus
WPM — Word Per Minute
APPENDIX C: A GUARDIAN LETTER
Dear Parent:

We are requesting the participation of your child in a study designed to help students improve their writing during school assignments. Our study seeks to determine if word prediction software can improve the speed and accuracy of student writing. Word prediction software helps students write by predicting an entire word after typing of only a few letters. It does this by “guessing” or predicting the word the person is typing with each letter. For example, if I want to type the word “prediction,” the software would give me a list of words that begin with “p” when I type the first letter. After I typed the “pr,” it would narrow the list to only those beginning only with “pr,” and so on. By the time I had typed “pred” the list would be reduced to only a few words including “predict” and “prediction.” I would then only need to pick the correct word and the program would type in the rest of the letters for me, which would make typing easier and quicker and with fewer errors.

The study will give each student several tasks including copying a short (100 words or fewer) passage without using word prediction. Next a similar passage will be typed with word prediction. We will also give the students an opportunity to write a short story using word prediction and compare it to a previous story written without word prediction. We expect to see an increase in typing speed and accuracy when the student uses word prediction.

The software will be provided free to the school so there will be no cost to either the school, your child, or you. Word prediction has been used successfully with several groups of students and is even included in some word processing programs, such as Microsoft Word®. At any time you can request your child not participate and your child also has the right to decline participation at any time. Choosing not to participate will NOT aﬀect their grades in any way.

Please read the attached permission form and, if your child is willing to participate and you are willing to permit their participation, please sign both copies of the permission form and return one copy to us. Keep the other copy and this letter for your records. Thank you for your help.

Sincerely,

Dr. Joe E. Wheaton, Associate Professor
Special Education
The Ohio State University

Mr. Theodoto Ressa
Special Education Master’s Student
The Ohio State University
APPENDIX D: PARENTAL CONSENT FORM
The Ohio State University Parental Permission

For Child’s Participation in Research

Study Title: The Effect of Word Prediction Program on Learners with Special Needs in Writing

Researcher: Theodoto Ressa

Sponsor:

This is a parental permission form for research participation. It contains important information about this study and what to expect if you permit your child to participate. Your child’s participation is voluntary. Please consider the information carefully. Feel free to discuss the study with your friends and family and to ask questions before making your decision whether or not to permit your child to participate. If you permit your child to participate, you will be asked to sign this form and will receive a copy of the form.

Purpose: This study will investigate and collect empirical data on the effect of word prediction program on quantity and quality of writing of special needs learners with writing problems.

Procedures/Tasks: During the training phase, the observers will train your child on the most convenient way to insert text using a word processor with word prediction. Your child will be taught to type two letters then look at the word prediction list (a “two-letters-then-search” strategy). The word prediction list will follow the cursor and the list of words will be limited to four words. Your child will then be able to select the correct word from this list. Your child will be considered to have learned the word prediction strategy after completing 10 consecutive words without the researcher’s assistance. The writing process will take approximately 30 minutes. During the training phase, the researcher will model writing techniques by typing a sentence of ten words from a printed text, for example: Jane is a beautiful girl and she comes from Columbus, or As the river roared through the jungle, monkeys chirped noisily. The observer and the child will type only one story during the training session to avoid confusion.

After mastering how to use word prediction, we will ask your child to write a short story by copying. Two stories will be written: one using word prediction and the other without it. For each story, we will record the time it takes to type the story and count the number of words typed and the number of errors.

The training and testing may be conducted in a room away from distractions with the researcher and/or school personnel present. If your child has any difficulty with the
operation of the word processor or word prediction, he or she will be given assistance as needed. After each session, your child will have an opportunity to choose an activity they enjoy doing (for example, playing a computer game).

We will print the output and, if your child wishes, save the work on the computer. Praise and a token (for example, a sticker of a favorite animal) may be given to your child at the end of each session to maintain your child’s interest and reward performance. The token will be negotiated with your child and approved by you. Your child will earn a token when he or she demonstrates good effort during a typing session. What constitutes “good effort” will be negotiated with your child.

We will collect information on the student’s age, gender, and disability, but no other demographic information will be collected.

**Duration:** It is estimated that the whole research will take four weeks with participants completing several 10-30 minute training sessions over a 3-5 day period and then participating in similar testing sessions. **Total estimated time of the student’s involvement in the study will be 2-8 hours per week depending on the student’s rate of working.** Your child may choose to leave the study at any time. If you or your child decides to stop participation in the study, there will be no penalty and neither you nor your child will lose any benefits to which you are otherwise entitled. Your decision to participate will not affect your future relationship with your child’s teacher or The Ohio State University.

**Risks and Benefits:** The findings will provide interventionists, therapists and educators important information on the effectiveness of software designed to enhance the writing process. The potential benefit for the participants and other school students is the use of assistive technology to improve their written expression. The benefits outweigh the risk because the student's data will only be recorded using a fictitious name so, even if it were seen by someone outside the study, your child could not be identified. Moreover, all materials will be in the possession of the researchers at all times to avoid any unauthorized person from gaining access to them. Finally, the information would be of little interest to anyone other than the investigators.

The student’s assent to participate in the study will only be requested after you have given us permission for the student to take part in the study.

**Confidentiality:** Efforts will be made to keep your child's study-related information confidential by using false names (pseudonyms), crypting essays, and storing all materials under lock and key. However, there may be circumstances where this information must be released. For example, personal information regarding your child’s participation in this study may be disclosed if required by state law. In such an event,
Appendix D continued

your child's records will be screened to obtain minimal information to be included anonymously to describe the group. In addition, the following groups (as applicable to the research) may review your child’s records:

- Office for Human Research Protections or other federal, state, or international regulatory agencies;
- The Ohio State University Institutional Review Board or Office of Responsible Research Practices

Incentives: No incentives are being offered.

Participant Rights:
You or your child may refuse to participate in this study without penalty or loss of benefits to which you are otherwise entitled. If you or your child is a student or employee at Ohio State, your decision will not affect your grades or employment status.

If you and your child choose to participate in the study, you may discontinue participation at any time without penalty or loss of benefits. By signing this form, you do not give up any personal legal rights your child may have as a participant in this study.

An Institutional Review Board responsible for human subjects research at The Ohio State University reviewed this research project and found it to be acceptable, according to applicable state and federal regulations and University policies designed to protect the rights and welfare of participants in research.

Contacts and Questions:
For questions, concerns, or complaints about the study you may contact Theodoto Ressa at 614-288-0104 or Dr. Joe Wheaton at 614-292-8313.

For questions about your child’s rights as a participant in this study or to discuss other study-related concerns or complaints with someone who is not part of the research team, you may contact Ms. Sandra Meadows in the Office of Responsible Research Practices at 800-678-6251.

If your child is injured as a result of participating in this study or for questions about a study-related injury, you may contact Dr. Joe Wheaton at 614-292-8313.

Signing the parental permission form
I have read (or someone has read to me) this form and I am aware that I am being asked to provide permission for my child to participate in a research study. I have had the
Appendix D continued

opportunity to ask questions and have had them answered to my satisfaction. I voluntarily agree to permit my child to participate in this study.

I am not giving up any legal rights by signing this form. I will be given a copy of this form.

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**Printed name of subject**

**Printed name of person authorized to provide permission for subject**  **Signature of person authorized to provide permission for subject**

**Relationship to the subject**  **Date and time**

**Investigator/Research Staff**

I have explained the research to the participant or his/her representative before requesting the signature(s) above. There are no blanks in this document. A copy of this form has been given to the participant or his/her representative.

**Printed name of person obtaining consent**  **Signature of person obtaining consent**

**Date and time**
APPENDIX E: PARTICIPANT ASSENT FORM
The Ohio State University Assent to Participate in Research

**Study Title:** THE EFFECT OF WORD PREDICTION PROGRAM ON CREATIVE WRITING OF SPECIAL NEEDS LEARNERS WITH WRITING PROBLEMS

**Researcher:** Joe Wheaton, PhD and Theodoto Ressa, BE.D

**Sponsor:**

- You are being asked to be in a research study. Studies are done to find better ways to treat people or to understand things better.
- This form will tell you about the study to help you decide whether or not you want to participate.
- You should ask any questions you have before making up your mind. You can think about it and discuss it with your family or friends before you decide.
- It is okay to say “No” if you don’t want to be in the study. If you say “Yes” you can change your mind and quit being in the study at any time without getting in trouble.
- If you decide you want to be in the study, an adult (usually a parent) will also need to give permission for you to be in the study.

1. **What is this study about?**

When you type a letter, word prediction program predicts what you might want to write and displays a list of correctly spelled words from which you can choose. When you see the word you want, you can choose it with a single keystroke or with the mouse.

2. **What will I need to do if I am in this study?**

During training phase, the investigator will physically train you on the most convenient way to insert text by using keyboard or onscreen keyboard, word processor, and word processor with word prediction. You will be taught to type two letters then look at the word prediction list ("two-letters-then-search" strategy); since it balances visual-cognitive demands and keystroke savings for individuals with slow visual scanning abilities (Koester & Levine, 1998). The word prediction list will follow the cursor to reduce strain in changing eye position. The word prediction window list will be limited to four words. The speech synthesis will be deactivated, however after saving the essay, it is optional, and you may use it to read the completed text entry.

*Continued*
Appendix E continued

3. How long will I be in the study?
It is estimated that the whole research will take three weeks with participants completing several 10-30 minute training sessions over a 3-5 day period and then participating in similar testing sessions. Total estimated time of the students involvement in the study will be 2-8 hours per week depending on students’ rate of working.

4. Can I stop being in the study?
You may stop being in the study at any time.

5. What bad things might happen to me if I am in the study?
Fatigue when using word prediction window list, text, and keyboard.

6. What good things might happen to me if I am in the study?
You will learn how to use word prediction program, type high quantity and quality essay, improve on your spelling, computer skills, and social acceptance.

7. Will I be given anything for being in this study?
No material incentive, however the investigator will show his goodwill throughout the study.

8. Who can I talk to about the study?
For questions about the study you may contact Prof. Joe Wheaton (614-292-8313) and Theodoto Ressa (614- 288- 0104) or the classroom special education teacher, or any other person you are comfortable with.

To discuss other study-related questions with someone who is not part of the research team, you may contact Ms. Sandra Meadows in the Office of Responsible Research Practices at 1-800-678-6251.

Signing the assent form
I have read (or someone has read to me) this form. I have had a chance to ask questions before making up my mind. I want to be in this research study.

_________________________________________  ____________________________  AM/PM
Signature or printed name of subject  Date and time

Continued
Appendix E continued

I have explained the research to the participant before requesting the signature above. There are no blanks in this document. A copy of this form has been given to the participant or his/her representative.

<table>
<thead>
<tr>
<th>Printed name of person obtaining assent</th>
<th>Signature of person obtaining assent</th>
<th>AM/PM</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Date and time

This form must be accompanied by an IRB approved parental permission form signed by a parent/guardian.
APPENDIX F: IRB APPROVAL LETTER
August 31, 2009

Protocol Number: 2009B0128
Protocol Title: THE EFFECT OF WORD PREDICTION PROGRAM ON CREATIVE WRITING OF SPECIAL NEEDS LEARNERS WITH WRITING PROBLEMS, Joe Wheaton, Theodoto Ressa, Physical Education and Educational Services
Type of Review: Initial Review—Expedited
IRB Staff Contact: Jacob R. Stoddard
Phone: 614-292-0526
Email: stoddard.13@osu.edu

Dear Dr. Wheaton,

The Behavioral and Social Sciences IRB APPROVED BY EXPEDITED REVIEW the above referenced research. The Board was able to provide expedited approval under 45 CFR 46.110(b)(1) because the research presents minimal risk to subjects and qualifies under the expedited review category(s) listed below.

Date of IRB Approval: August 31, 2009
Date of IRB Approval Expiration: June 8, 2010
Expedited Review Category: 7

In addition, the protocol has been approved for the inclusion of children (permission of one parent sufficient).

If applicable, informed consent (and HIPAA research authorization) must be obtained from subjects or their legally authorized representatives and documented prior to research involvement. The IRB-approved consent form and process must be used. Changes in the research (e.g., recruitment procedures, advertisements, enrollment numbers, etc.) or informed consent process must be approved by the IRB before they are implemented (except where necessary to eliminate apparent immediate hazards to subjects).

This approval is valid for one year from the date of IRB review when approval is granted or modifications are required. The approval will no longer be in effect on the date listed above as the IRB expiration date. A Continuing Review application must be approved within this interval to avoid expiration of IRB approval and cessation of all research activities. A final report must be provided to the IRB and all records relating to the research (including signed consent forms) must be retained and available for audit for at least 3 years after the research has ended.

It is the responsibility of all investigators and research staff to promptly report to the IRB any serious, unexpected and related adverse events and potential unanticipated problems involving risks to subjects or others.

This approval is issued under The Ohio State University’s OHRP Federawide Assurance #00006378.

All forms and procedures can be found on the ORRP website – www.orrp.osu.edu. Please feel free to contact the IRB staff contact listed above with any questions or concerns.

Shari R. Speer, PhD, Chair
Behavioral and Social Sciences Institutional Review Board
APPENDIX G: IOA FOR PERMANENT PRODUCTS
### Tasks

<table>
<thead>
<tr>
<th></th>
<th>Copying text</th>
<th>Descriptive writing</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sessions</strong></td>
<td>4 7 9 12 17</td>
<td>4 7 9 12 17</td>
</tr>
<tr>
<td><strong>Experimenter</strong></td>
<td>73 78 77 77 106</td>
<td>59 57 97 70</td>
</tr>
<tr>
<td><strong>Observer</strong></td>
<td>73 76 77 77 106</td>
<td>59 57 97 70</td>
</tr>
<tr>
<td><strong>IOA</strong></td>
<td>A D A A A A A A A</td>
<td>A A A A A A A A A</td>
</tr>
</tbody>
</table>

**IOA Total typed words**

<table>
<thead>
<tr>
<th></th>
<th>Copying text</th>
<th>Descriptive writing</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sessions</strong></td>
<td>4 7 9 12 17</td>
<td>4 7 9 12 17</td>
</tr>
<tr>
<td><strong>Experimenter</strong></td>
<td>7 4 1 3 3</td>
<td>8 4 2 13 6</td>
</tr>
<tr>
<td><strong>Observer</strong></td>
<td>8 4 1 3 3</td>
<td>11 4 3 15 6</td>
</tr>
<tr>
<td><strong>IOA</strong></td>
<td>D A A A A</td>
<td>D A D A A</td>
</tr>
</tbody>
</table>

**IOA Total errors**

**IOA Occurrence** = A occurrence / (A occurrence + D occurrence) x 100

**IOA Occurrence** = 16/ (16 + 4) x 100 = 80%
APPENDIX H: PARTICIPANT’S SPELLING ERRORS ACROSS TASKS
| Duplicated | actual, Sometimeing, pille, family, peasons, namelly, outside, cann, |
| Combined   | itcan, allay, |
| Inserted   | speack, whent, |
| Added      | animale, buud, parenst, abusisse (abusive), whant (want), helpe (help), sicke (sick), frome, kides, thay, talke, musice, hade, grey-matteed (gray-matteed), comit (commit), ower (over), friends, dounts, indside, kides, almose (almost), owere, pille, alll, familly, namelly, diead, vehicleas, disper, aluminium (aluminum, dow (down), televison |
| Omitted    | disapering (disappearing), buglary (burglary), aportion (apportion), belive (believe), hem (them), ha (had), comit (commit), dameg (damage), tha (that), hevy, stabe (stable), minut (minute), punkin fesibely (pumpkin festival), peole (people), romace langes (Roman languages), migt, scaed (scared), agin (again), frends, leav, sacrifice, bulding, boling, funiter, remots, peole, finlly, althogh, buld, squising, nife (knife), blak (black), sysyem (system), everone (everyone), finih, responsibilites, sensitve, spirt, atted (attend), chuch, contenu, gt, migt (might), mounans, gows, willingenes, sacrifice, explanis, leav, disappearnces, televison, red (read), cecking (checking), volcanos, whi (which), formule |
| Transposed | fuor (four), ti (it), calw, pepole, paly, official, obedinet, nad, grandfatehr, papae, oyur, officail, deat, eals (else), tabels, hiar (hair) |
| Inverted   | buring (during), disodeyed (disobeyed) |
| Split      | every thing, your self, in side (inside), out side, every one (everyone), with out, mean while |
| Separated  | a bout, |
| Substituted| hin (him), eals, jone, humen, insans, diead, mestory, avanchehr, Brecing (bracing), amd, heacy (heavy), sureside (suicide), dameg (damage), mattr (Mathew) himeslef, sadin, thecher (teacher), thacher, hallwas, ower, contenu, heets, honrin, Circal, tickes, punking, freinds, nack (back), choculit (chocolate), slading, basile, almose, wath, maustan, eartquick, mounans, mountan, moslay, suer, tactonic, normely, afeaid, owere, storie, causions, informason, avwl, chuch, enoth,ograu, thanl stud againg, emoynal, popular, exeside, sore, deat, favie, finih, jale, there (their), know (no), hared (heard), thow (though), groung (ground), enoth (enough), thanl, stad, againg, choculit, flasing, tickes, nack (back), sroy, thay, basile (basically), heets (meets), eartquick, causions (cousins), afeaid (afraid), popular, exeside, favie (five), weopens, jale (jail), informason, disodeyed, peasons, cuver, funiter (furniture), cause (case), fictaion (fiction), wic (wich), storys (stories), formule (formula), ture (true) |
APPENDIX I: TOPICS FOR DESCRIPTIVE WRITING
Personality: Describe the following characters

1. Cole Mathews
2. Peter Driscal
3. Spirit Bear
4. Grandparents
5. Your friend

Activities: Describe what:

1. Circle Justice
2. Pumpkin Festival
3. Camping - the soaking in the frozen water, climbing the steep hill and rolling the stone
4. How to prepare for exam
5. Research routine/ swimming
6. Describe how someone may come to your school from Downtown Columbus

Things: Describe things you …

1. Camping
2. Learning Spanish
3. Computer
4. Car
5. An elephant
6. Wee games

Continued
Appendix J continued

7. Favorite movie

Places: Describe the

1. Alaskan island where Cole was banished
2. Library
3. Mountain

Events: Describe the event

1. That led to Cole being mauled by the bear
2. Fire drill
3. Snow day
4. Foster kids party
5. Thanksgiving

Feelings: Describe an event in the novel that stands out emotionally

1. The mauling of Cole Mathews by a bear
2. A sad day in my life/ anger/ falling in love/ A memorable day
3. Scenes: Describe the scene
4. Disaster- Flooding
5. What happened when Cole’s picked on Peter
6. A winter season/ A rainy day/ A lightening
APPENDIX J: TASK ANALYSIS FOR WRITING
Task analysis shows how a task was accomplished. It gives the detailed description of both typing and mental activities, the tasks and element durations, task frequency, task allocation, task complexity, environmental conditions, and device required the participant to perform a typing.

1. Experimenter switches on the computer.
2. Open your word processing program.
3. Experimenter sets word processor.
4. Experimenter sets word prediction (Depending on the session).
5. Experimenter checks the settings.
6. Experimenter puts the text on the screen.
7. Participant walks into the study room.
8. Participant sits correctly on the chair and get comfortable.

*Descriptive Writing.*

9. Participant /experimenter chooses a topic (if starting with Part 2).
10. Experimenter gives prompt before the descriptive writing.
11. Experimenter discusses the topic with the participant for two minutes.

*Copying Text.*

12. Experimenter puts the text on screen.
13. Participant waits for the command “Begin” to start typing.
14. Experimenter immediately switches on the stopwatch.
15. Participant copy the onscreen text onto word processor.

*Continued*
Appendix K *continued*

16. Participant types until completion of the task or for maximum 10 minutes.

17. At the end participant says “Finished.”

18. Experimenter keeps watch as the participant types.

19. Experimenter marks the Momentary Time Sampling Table at the end of every minute.

20. Experimenter stops the watch after participant types the last letter/ says “Finished.”

21. Participant is given two minutes break between tasks.

*Descriptive Writing.*

22. Participant begins Part 2 after the command “Begin.”

23. Experimenter immediately switches on the stopwatch.

24. Participant types for 10 minutes or until says “Finished.”

25. Experimenter keeps watch as the participant types.

26. Experimenter marks the Momentary Time Sampling Table at the end of every minute.

27. Experimenter stops the watch after participant types the last letter/ says “Finished.”

28. Participant is allowed to go.

*Word prediction.*

29. Participant look at the pooping words.

30. Chooses the appropriate one by clicking the numbers on the keyboard.
APPENDIX K: CO:WRITER SET FEATURES
<table>
<thead>
<tr>
<th>Feature</th>
<th>Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lexicon size and type</td>
<td>adapted for the writer and task</td>
</tr>
<tr>
<td>Adaptive learning</td>
<td>off</td>
</tr>
<tr>
<td>Save lexicon automatically</td>
<td>on</td>
</tr>
<tr>
<td>Smart punctuation</td>
<td>on</td>
</tr>
<tr>
<td>Affixes</td>
<td>on</td>
</tr>
<tr>
<td>Repeated predictions</td>
<td>on</td>
</tr>
<tr>
<td>Recent word use</td>
<td>on</td>
</tr>
<tr>
<td>Next word prediction</td>
<td>on</td>
</tr>
<tr>
<td>Speech synthesizer</td>
<td>on</td>
</tr>
<tr>
<td>Fixed/dynamic prediction</td>
<td>dynamic</td>
</tr>
<tr>
<td>Space</td>
<td>Single-spaced</td>
</tr>
<tr>
<td>Prediction</td>
<td>flexible spelling</td>
</tr>
<tr>
<td>Guesses</td>
<td>best guesses first or alphabetical guesses</td>
</tr>
<tr>
<td>Display</td>
<td>word window</td>
</tr>
<tr>
<td>Window position and size</td>
<td>follow the cursor and small</td>
</tr>
<tr>
<td>Number of predictions</td>
<td>5 words</td>
</tr>
<tr>
<td>Text font, size and colors</td>
<td>Arial, 14, green</td>
</tr>
</tbody>
</table>
APPENDIX L: TASK ANALYSIS FOR PARTICIPANT SURVEY
After the last session, the experimenter switches on the social validity survey. Experimenter explains to the participant the goal of the questionnaire. The goal is to evaluate participant’s disposition to use of word prediction. Participant is not told how marks for each question are allocated. Participant reads each question before choosing it. Participant clicks on one choice per question. Participant types answer to question 12. On completion the participant is praised and given a small gift. Participant goes to class.
APPENDIX M: PARTICIPANT SURVEY
1. *Co:Writer* made me write more.

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Undecided</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>


<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Undecided</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>


<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Undecided</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

4. *Co:Writer* increased the time I spent writing.

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Undecided</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

5. *Co:Writer* improved my confidence when typing.

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Undecided</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

6. How satisfied were you with the training on *Co:Writer*?

<table>
<thead>
<tr>
<th>Not at all</th>
<th>Not very</th>
<th>Neutral</th>
<th>Somewhat</th>
<th>Very</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

7. Did you like using *Co:Writer*?

<table>
<thead>
<tr>
<th>Not at all</th>
<th>Not very</th>
<th>Neutral</th>
<th>Somewhat</th>
<th>Very</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

8. How often would you use *Co:Writer*?

<table>
<thead>
<tr>
<th>Never</th>
<th>Rarely</th>
<th>Sometime</th>
<th>Often</th>
<th>Always</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

9. Would you use *Co:Writer* when emailing friends?

<table>
<thead>
<tr>
<th>Very unlikely</th>
<th>Unlikely</th>
<th>Neutral</th>
<th>Likely</th>
<th>Very likely</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

10. How comfortable were you with the procedures used to learn *Co:Writer*?

    | Not at all | Not very | Neutral | Somewhat | Very |
    |------------|----------|---------|----------|------|
    | 1          | 2        | 3       | 4        | 5    |

Continued
Appendix N continued

11. Would you recommend use of Co:Writer to needy students?

<table>
<thead>
<tr>
<th></th>
<th>Very unlikely</th>
<th>Unlikely</th>
<th>Neutral</th>
<th>Likely</th>
<th>Very likely</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recommendation</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

12. Additional Comments
I really did like using the Co:Writer.
APPENDIX N: SAMPLES OF PARTICIPANT’S COPYING TEXT WORK
**Training:** (Touching Spirit Bear by Ben Mikaelsen)

Cole Matthews knelt defiantly in the bow of the aluminium skiff as he faced forward into a cold September wind. Worn steel handcuffs bit at his wrists each time the small craft slapped into another wave. Overhead, a grey-matteed sky hung like a bad omen. Cole strained at the cuffs even though he had agreed to wear them until he was freed on the island to begin his banishment. Agreeing to spend a whole year alone in Southeast Baseline: (Touching Spirit Bear)

Not that it really matter He had no intention of ever honrin the contract he agreed to buring the circle Justie metings As soon as they left him alone, this silly game would end. Circa justice was a bunch of buul. They thought he was going to spend a whole year of this life like some animale trapped on a remote Alaskan island. Cole twisted at the handcuffs again. Last year at this time he ha never even heard

**Treatment:** (Among the Hidden by Margaret Peterson Haddix)

Jen begins to show Luke that what the government has done is wrong. She organizes a rally in Support of the third children and asks Luke to come but Luke refuses, afraid of what might happen. After not hearing from Jen for two weeks luke runs over to her house where he heets Jen’s father, George Talbot a population police officail luke finds out that everyone at the rally was shot and killed including Jen
APPENDIX O: SAMPLES OF PARTICIPANT'S DESCRIPTIVE WRITING
**Training:** (Description of novel *Left Behind* by Tim LaHaye)

I had read a book called *Left Behind* which was about four kids that had missed the return of Cries and it tells how these four kids will survive with others that were also left behind while people just keep disappearing in front of their eyes.

**Baseline:** (Pumpkin Festival)

On Sunday I went to the pumpkin festival. It was fun and something new because I had never been there before. There were games that people could play and win prizes. There were also rides that you could get on. But you had to buy tickets. There were also food counters, but you had to pay for the food. Everything was made with pumpkin - pumpkin fries, doughnuts, and more. There was also some people singing. It was a fun place to go with friends.

**Treatment:** (Description of a computer)

A computer is a machine that basically does everything that you can almost think of. A computer has a lot of stuff. It can tell the weather and it can do math. You can watch videos on it and move it. It can also say things and it can also write. It can help you with your work and you can talk to other people in different states. In you can go to school on it and you can play a lot of fun games on it and you can get the news on it too.