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Efficacy of a Computer-Based Editing Strategy with Postsecondary Students with Intellectual and Developmental Disabilities

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Abstract: The authors in this study used a pre-posttest experimental design with random assignment to treatment or control group to assess the use of an electronic editing cognitive strategy. The participants were 16 college students with intellectual and developmental disabilities enrolled in a 2-year postsecondary program at a Midwestern institute of higher education. Students who were taught the strategy received eight 50-minute lessons once a week for eight weeks. Each strategy lesson was driven by the strategy mnemonic and incorporated an explicit instruction format with modeling, guided practice with feedback, and independent practice. Strategy instruction included students using desktop PCs and Microsoft Word to identify and correct editing errors in electronic passages. Posttests revealed a significant difference in favor of the treatment group for total editing errors corrected and specific error types corrected for spelling, punctuation, and substance. No significant difference was found for overall appearance and capitalization errors. Two weeks following posttest, a maintenance probe revealed that students in the treatment group corrected a significantly higher number of editing errors than those in the control group.

Over the last decade there has been an upsurge in the number of postsecondary programs that support college students with intellectual and developmental disabilities (IDD) at institutes of higher education (IHEs) within the United States. Federal government incentives, such as the Higher Education Opportunity Act (HEOA) 2008 have afforded individuals with IDD improved access to higher education. It has been a decade since the enactment of the HEOA. Today potential college applicants with IDD can apply for federal financial aid along with their college-age peers without disabilities, and students with IDD have a greater number of IHE programs from which to choose (Grigal et al., 2018, 2017; Smith Lee, 2009). As the number of IHE programs that support students with IDD increase there is a pressing need to employ effective instructional strategies within these settings. Specifically, there is a need to identify strategies that can empower students with IDD to successfully engage in academic tasks such as writing in digital environments.

Writing in the 21st century requires one to have mastery of digital competencies when

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constructing and revising written text (DeVoss et al., 2010; Hayes & Olinghouse, 2015; Karchmer-Klein, 2013; Lewis, 2000; Regan et al. 2018). The 2010 *Common Core State Standards for English Language Arts & Literacy* support the use of technology in the writing process and note that college-ready writers must utilize technology in a strategic fashion when planning, constructing, and editing their own writing (National Governors Association Center for Best Practices & Council of Chief School Officers, 2010). Individuals with disabilities can benefit from strategy instruction that supports the use of word processing via computers or tablets to construct and edit written text (Englert et al., 2010; Graham et al., 2016; Graham & Perin, 2007; Silió & Barbetta, 2010). Current editing functions in word processing programs, such as spell check require the user to expand beyond accepting the provided answers and to engage in actions such as: (a) further examining the misspelled word if no acceptable answers are provided, (b) inspecting words that are homophones, and (c) reading the text aloud to identify misused words that are spelled correctly.

Postsecondary academic demands in writing span across a myriad of content and subject matter and require students to construct written assignments in an electronic form. Individuals with IDD who begin their IHE postsecondary experience with long standing difficulties in the area of written expression will continue to experience problems in academic writing tasks unless instructional support is provided. The writing process is a complicated iterative task that encompasses aspects of motivation, pre-planning, constructing a written product, and revision (Hayes, 2012; Hayes & Flower, 1987).

Individuals with IDD who struggle in written expression can experience problems with writing for a specific purpose, constructing organized written passages, revising their work, and difficulty in employing meta-cognitive skills (e.g. accessing and using writing strategies, evaluating one's own writing, revising and self-checking; Cannella-Malone et al., 2015; Connelly & Dockrell, 2016; Jackson et al., 2018; Joseph & Konrad, 2009; Konrad et al., 2006; Pennington, 2016; Pennington & Delano, 2012). As Hua et al. (2018) noted, young adults with IDD "may not derive the full benefits from postsecondary education" because of their persistent difficulties in literacy skills, such as constructing and revising written text (p. 1). In addition, postsecondary learners with IDD can experience barriers to effectively writing and revising even in electronic platforms, such as using computers to construct text due to lack of knowledge in how to use existing writing tools (e.g., spell checker, etc.). College students with IDD can benefit from using cognitive strategies that target editing and revising tasks in their electronic construction of texts which include identifying and correcting grammatical errors and making substantive corrections (Woods-Groves et al., 2017, 2015). These strategies provide students with mnemonic cues to aid in the recall of strategy steps and provide students with guidance in revising during the writing process (Hughes et al., 2010).

When writing within a digital platform such as using computers or tablets, previous studies have supported the use of strategy instruction in supporting learners with disabilities in utilizing digital tools included in most writing programs such as spell check, dictionary, thesaurus, and editing tools (Cullen et al., 2008; Graham et al., 2016; Graham & Perin, 2007; Hetzroni & Shrieber, 2004; Montgomery et al., 2001; Pennington, 2016; Wong, 2001). A meta-analysis conducted by Graham et al. (2016) revealed support for the following writing strategies for elementary and secondary learners: (a) teaching strategies to support word processing ($d = 1.46$), (b) setting writing goals ($d = .80$), and (c) using explicit writing instruction in writing strategies ($d = 1.26$).

Cognitive strategy instruction is effective for students with and without disabilities in significantly improving writing and reading skills (Archer & Hughes, 2010; Conderman et al., 2013; Deshler & Schumaker, 1986; Englert; 1992; Graham, 2006; Harris et al., 2010; Hughes et al., 2017; Schumaker & Deshler, 2009). Cognitive strategy instruction in writing includes setting goals, selecting and successfully employing a learning strategy, monitoring oneself throughout strategy use, maintaining one's motivation throughout strategy use, and evaluating the execution of strategies (Arthur & Graham, 2016; Philippakos et al., 2015; Zimmerman, 2000). While empirical support for the efficacy of

strategy writing instruction with elementary and secondary learners with disabilities can be found, there is a need to investigate the use of cognitive strategy instruction with postsecondary learners with IDD in IHE settings.

A cognitive strategy instruction designed to teach editing skills within electronic platforms is the EDIT Strategy. The EDIT Strategy was developed by Hughes et al. (2010) through a combination of the Error Monitoring Strategy (Schumaker et al., 1985) and the InSPECT Strategy (Naughton & Hughes, 1999). The EDIT Strategy is a hybrid intervention that incorporates teacher-led explicit instruction, guided practice, and independent practice to teach students how to effectively use computer-based editing functions within word documents. The strategy was designed to teach students how to identify and correct grammatical errors in their digital word documents. EDIT is a mnemonic device which represents the four steps of the strategy: a) Enter your first draft; b) Do a spell check; c) Interrogate yourself using the capitalization, overall appearance, punctuation, and spelling (COPS) questions, and d) Type in corrections and run the spell-checker (Hughes et al., 2010). In addition to the mnemonic, the EDIT strategy uses explicit instruction procedures (Archer & Hughes, 2009), mastery-based learning (Schumaker & Deshler, 2009), and goal setting and self-evaluation (Schunk & Zimmerman, 2007) to guide participants through the digital editing process.

There have been three previous investigations of the EDIT intervention to date. Carranza and Hughes (2009) first studied the effects of EDIT with 22 elementary and middle school students with learning disabilities (LD) who were randomly assigned to treatment and control groups. The study lasted three weeks with a total of four instructional hours. The lessons included modeling of the intervention with teacher think-alouds, practice of the four EDIT steps, teacher guided practice with feedback and error correction, and independent practice. The dependent measure was a pre- and posttest electronic passage that contained 25 total errors, five for each of the EDIT categories: Spelling, Capitalization, Overall Appearance, Punctuation, and Substance. Treatment and control groups were compared on their EDIT Total score (i.e., the total number of errors corrected) and on their performance for each of the five error categories. A comparison of the posttest probes revealed that the treatment group outperformed the control group. In addition, the treatment group improved upon their pre-test scores from 28% to 80% of total errors corrected, and they maintained their skills when assessed several weeks after the study concluded.

Woods-Groves et al. (2015) studied the effectiveness of the EDIT strategy with 19 postsecondary students with intellectual and developmental disabilities (IDD). All participants were enrolled in a campus-based, 2-year certificate program at an Institute of Higher Education located in the Midwest. The investigators used a pre- and posttest design, randomly assigning participants to a treatment ($n = 11$) or control ($n = 10$) group. The strategy was taught in sixteen 50-minute lessons over eight weeks, for a total instructional time of 13.33 hours.

The dependent measure consisted of two electronic Microsoft word passages (i.e., California Redwoods and Giant Pandas) each from the EDIT Strategy manual and materials (Hughes et al. 2010). The two passages were adapted to the third-grade reading level and contained approximately 220 words each. Each passage contained 25 errors with five errors in each of the following areas: spelling, capitalization, overall appearance, punctuation, and substance. Scores from the prompts included a total score and scores for the five error types. Students were randomly assigned one of the two passages as a pretest and were assigned the remaining passage as a posttest. For instance, if one student was randomly assigned California Redwoods for a pretest then the student would have Giant Pandas as a posttest. This served as a counterbalance for the pre- and posttest assignments across participants. The treatment group performed significantly better than the control group on three areas: EDIT Total Score ($d = 1.01$, $p = .011$), Overall Appearance ($d = 1.06$, $p = .048$), and Punctuation ($d = 1.54$, $p = .004$). In addition, the treatment group maintained significant differences in performance on two areas 11 weeks after the intervention had con-

cluded: EDIT Total (d = 1.19, p = .029) and Overall Appearance (d = 1.67, p = .004).

Woods-Groves et al. (2017) investigated the EDIT strategy with 15 postsecondary students with IDD. Woods-Groves et al. (2017) shortened the overall instruction time reported in Woods-Groves et al. (2015) by reducing lessons pertaining to using the spell checker. In this investigation the participants were randomly assigned to treatment (n = 7) and control (n = 8) groups with a pre-/posttest design. The EDIT strategy was delivered to the treatment group in 11 sessions that lasted 45-minutes over 5.5 weeks. The total instructional time was 8.25 hours. Woods-Groves and colleagues extended the pre- and posttest probe ranges by adding five more grammatical errors to the prompts for each error category which increased the total errors from 25 to 30 per probe. All prompts were written at the third-grade level and averaged 220 words each.

Even with the shorter instructional time, the researchers found significant differences between the treatment and control groups on four measures: EDIT Total (d = 0.84, p = .006), Spelling (d = 0.71, p = .022), Punctuation (d = 0.96, p = .030), and Substance (d = 1.66, p = .007). The investigation also included two maintenance periods, one at five weeks after the intervention and another at 12 weeks post-treatment. The five-week maintenance phase revealed significant differences in measures identical to the post-test: EDIT Total (d = 1.01, p = .003), Spelling (d = 0.97, p = .009), Punctuation (d = 1.17, p = .023), and Substance (d = 1.13, p = .022). The 12-week maintenance phase comparisons yielded significant differences in three areas: EDIT Total (d = 0.41, p = .014), and Spelling (d = 0.60, p = .042), Punctuation (d = 0.90, p = .025).

In the previous two EDIT investigations conducted by Woods-Groves and colleagues the findings supported the use of the strategy with college students with IDD, however the results were not conclusive. In Woods-Groves et al. (2015), students who were taught the strategy (treatment group) significantly corrected a higher number of overall appearance and punctuation errors than students in the control group. In the second EDIT investigation with college students with IDD, students who were taught the strategy significantly outperformed those who were not taught the strategy in the number of corrected spelling and punctuation errors. Neither study revealed an improvement in the area of substantive errors corrected while only the area of punctuation showed consistent effects across the two studies.

It is important to identify potentially effective strategies to improve the writing skills of students with IDD enrolled in postsecondary programs. Potential strategies must be experimentally tested within authentic settings with the target population for which they are intended to be used. This current investigation is designed to further examine the use of the EDIT strategy with college students with IDD.

The following research questions were investigated:

1. Will participants in the EDIT Strategy instructional group independently correct a higher number of editing errors in electronic word passages than participants in the control group?
2. Will participants in the EDIT Strategy instructional group independently correct a higher number of editing error types including spelling, capitalization, overall appearance, punctuation, and substance in electronic word passages than participants in the control group?
3. Will participants who received the EDIT Strategy maintain their posttest performance during the maintenance stage?

Method

Participants

Sixteen postsecondary students with IDD participated in this study. A convenience sample was used in this study where all participants were young adults enrolled in a 2-year postsecondary campus-based program for individuals with IDD at a research one Midwestern university. The participants ranged in age from 20-to-22 years (M = 18.88, SD = 1.15). With regard to educational services, the participants were served under the following diagnostic categories: 2 (12.5%) with Autism, 2 (12.5%) with Pervasive Developmental Disorder-Not Otherwise Specified, 1 (6.3%) with

Fetal Alcohol Syndrome and Attention Deficit Disorder, 8 (50%) with an intellectual disability, 2 (12.5%) with an intellectual disability and cerebral palsy, and 1 (6.2%) with a learning disability and cerebral palsy.

There were seven (44%) females and nine (56%) males. With regard to race, there were 15 (94%) participants who were White and one (6%) participant who was Asian. The students were from rural 8 (50%), suburban 4 (25%), and 4 (25%) urban areas. All participants were assessed with the Woodcock Johnson Tests of Achievement III (WJIII; Woodcock et al., 2001). Across all the participants, WJIII Total Scores, with a mean of 100 and standard deviation of 15, ranged from 39 to 104, (*Mdn,* 72), while WJII Broad Reading scores ranged from 34 to 115, (*Mdn,* 53), and WJIII Broad Writing scores ranged from 28 to 116, (*Mdn,* 60). The WJII Total Scores were used to stratify all the participants, then a coin flip (i.e., tails = treatment group; heads = control group) was employed to randomly assign participants to treatment or control groups. There were eight students respectively assigned to the treatment and control groups.

Material

Materials from Hughes' et al. (2010) EDIT Strategy manual were used for this study. Six adaptations were made to the original EDIT Strategy materials. First, all the EDIT Strategy prompts for pre- and posttests and maintenance, and prompts used in lessons were adapted to the lowest reading level indicated across the participants. The participants' curriculum-based measurement oral reading fluency results via the Dynamic Indicators of Basic Early Literacy Skills (DIBELS; Good & Kaminski, 2002) oral reading fluency (i.e. DORF) indicated that the lowest reading level for all students was the third-grade level range. As a result, all EDIT Strategy materials were adapted to not exceed the third-grade level as determined by Flesh-Kincaid readability tests (Kincaid et al., 1975). Second, materials employed in each intervention lesson included an EDIT Strategy graphic organizer that contained the steps of the respective lesson for the session and a highlighter that students could use to check off each completed step on their graphic organizer. Third, USB memory sticks with electronic word files (i.e., guided practice, independent practice passages) for the respective lesson were provided to each student. Fourth, each student was given a folder with a graph to self-graph and monitor performance. The fifth adaptation to the strategy included providing the students with headphones and instructed to use the text-to-speech universal design function when reviewing their edit prompt during the strategy. The sixth and final adaptation to the strategy was the extension of the original four-hour total instructional time noted in Carranza and Hughes' (2009) investigation with students with LD.

During the EDIT Strategy intervention, the students were instructed in a large group format in a computer lab located at the university. This computer lab was a classroom that routinely held college classes for students enrolled in the university. The computer lab had four long tables with approximately five computers stationed at each table. The tables were arranged where students faced the front of the classroom where a smartboard, instructor lectern, document camera, and an overhead projector were located. Each student had a PC computer with a mouse, USB ports, and a monitor. The instructor was employed through the postsecondary program and regularly taught all the students in other courses within the postsecondary program (i.e., career development, finance, etc.). For each EDIT Strategy lesson the instructor employed a projector, Smartboard, and a PC desktop computer at the front of the computer lab to teach each lesson. See EDIT Graphic Organizer in Figure 1.

Design and Procedure

Design. An experimental pre-/posttest design was employed in this study. A coin flip procedure was conducted to assign 16 students to treatment or control groups. As noted previously, the students were stratified based upon their WJIII Total Scores then assigned via coin flip to respective groups (i.e., tails = treatment group; heads = control group). There were eight students in each group (i.e., treatment and control). The WJIII Total Scores for the participants that were assigned to respective groups were compared via an Analysis of Variance (ANOVA) and re-

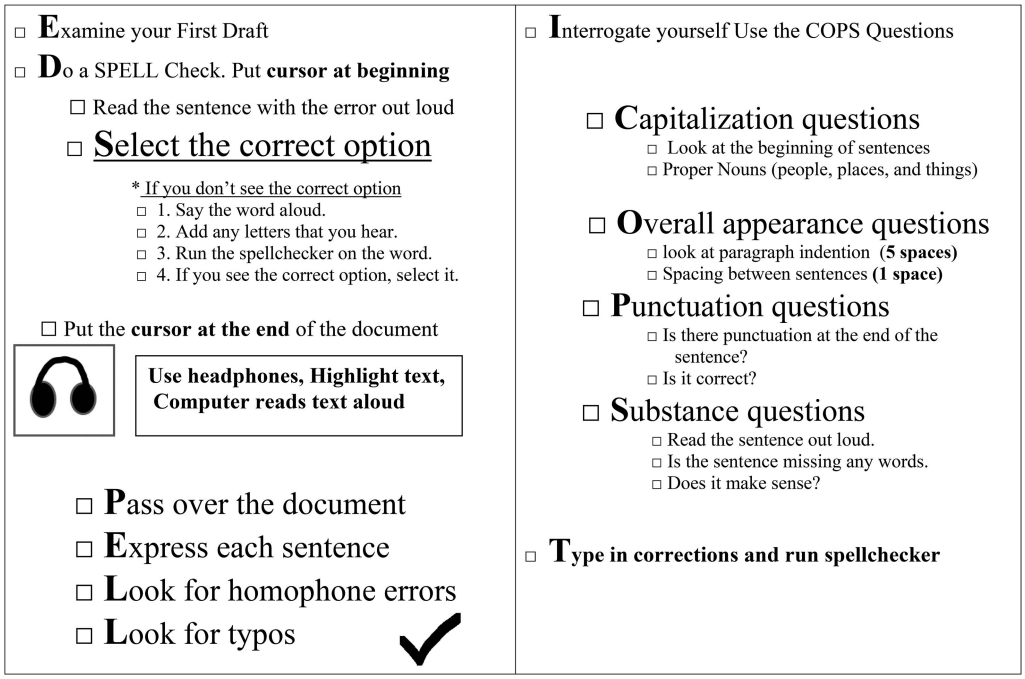

Figure 1. EDIT Strategy Graphic Organizer (adapted from Hughes et. al., 2010).

vealed no significant differences between the groups $F(1, 15) = .160$, $p = .695$, treatment group ($M = 68.38$), control group ($M = 72.50$).

The participants in the treatment and control groups were administered a pretest one week preceding the beginning of the editing intervention and a posttest one week following the end of the intervention. The pre- and posttests were the "California Redwood" and the "Giant Panda" prompts. These two prompts were randomly assigned to participants in treatment/control groups. Administration of the prompts was counterbalanced. For example, if the "California Redwood" prompt was assigned to an individual as a pretest, then that individual was given the "Giant Panda" prompt for their posttest. The participants were administered a maintenance prompt three weeks following instruction and two weeks following the posttest.

The pre- and posttest prompts were adapted electronic versions of the "California Redwood" and "Giant Panda" prompts provided in the EDIT Strategy manual (Hughes et al., 2010). The prompts were revised to not exceed a third-grade readability level range as noted earlier. Each prompt consisted of a passage with approximately 220 words each. And contained 30 errors with six errors in each of the following areas: spelling, capitalization, overall appearance, punctuation, and substance. For each prompt the passage consisted of six spelling errors including two homophone and four words dispersed within the passage that were misspelled. Capitalization errors included a total of six errors for the beginning of the sentence and or proper nouns within the passage. Overall appearance errors included six errors consisting of errors in indention for paragraphs and errors for spacing between sentences. Punctuation errors included six errors throughout the passage that included the use of punctuations, such as periods and question marks. Substance errors were dispersed throughout the passage and included six instances of missing articles (e.g. the, a, and) and subjects. Each passage was scored using the EDIT Scoring key designed for each prompt that provided an answer key for the five error types for a total of 30 errors. In addition, each EDIT

Errors	Spelling ✓		Capitalization	Overall Appearance	Punctuation	Substance Missing Word
25	5	1 Homophone	5	4	5	5
Errors Corrected						
Errors Not Corrected						

_____ correct out of 25 = _____% _____total errors

Circle errors in document

Figure 2. Maintenance EDIT Strategy Scoring Key.

Scoring key provided a way to score and record each error type, and a rubric for totaling correct and incorrect responses. The maintenance prompt EDIT Scoring key was similar to the California Redwoods and Giant Panda EDIT Scoring keys, except that the maintenance scoring key had consisted of 25 errors with five errors for each error type. See Figure 2 for the maintenance EDIT Scoring key.

All assessments (i.e., pre-/posttest prompts and a maintenance prompt) were administered in a large group format in a computer lab. Each student had the respective electronic assessment on their PC desktop in a Microsoft Word document. Instructions included the following: "Please open the word document that has been placed on your desktop. You have 30 minutes to read the prompt and then run the spell checker. You are to correct any errors you find in your prompt" (adapted from Hughes et al., 2010). No participants performed above the study exclusion criterion of 80% or more total errors corrected in the pretest and were subsequently all included in the study.

Intervention. Several adaptations in the EDIT Strategy were implemented in this study that diverge from previous published investigations of the EDIT Strategy with college students with IDD (Woods-Groves et al., 2017, 2015). Adaptations included the following: (a) a reduction of the number of lessons taught in previous investigations of the EDIT Strategy with young adults with IDD from 16 and 11 lessons to eight 50 min. lessons once a week, (b) the use of assistive technology/universal design features in Microsoft Word (i.e., text to speech and headphones), and (c) the use of adapted graphic organizers to support strategy steps. These adaptations were designed to decrease the length of instructional time and to support students in their use of the strategy.

EDIT Strategy lessons were conducted once a week for eight 50-minute sessions. Total intervention time was 6 hours and 40 minutes. The instructor for the EDIT Strategy was a graduate student in counseling and was employed by the postsecondary IDD program as an official teacher in the program. The first author met weekly with the EDIT Strategy instructor to discuss aspects of upcoming lessons and instruction.

The sequence of each of the eight EDIT Strategy lessons is described below. Specific lesson content is included in Table 1. Aspects encompassed in each lesson included the following: (a) explicit instruction with modeling, guided practice with feedback and independent practice, (b) mastery-based learning to an 80% criterion before advancing to a new strategy step, (c) respective graphic organizers that addressed steps previously taught and current lesson steps, (d) highlighters, and (e) student folders with the EDIT mnemonic on the front, self-graphing table, and a guide for how to access and save electronic documents within each folder. Students were each given a point booklet that included the class expectations, such as arriving on time, completing independent practice with 80% mastery, and participating in class. Students graphed their performance for independent practice and critiqued their behavior regarding following class expectations by assigning themselves points within their point booklet at the end of each session. Points for the class were cumulatively summed each week and "banked" for the goal of having a pizza party.

TABLE 1

Components of EDIT Strategy Lessons (adapted from Hughes et al., 2010)

Lesson	*Sessions*	*Lesson Activities*
1	1	The instructor defined editing and asked students to identify difficulties they encounter when writing and editing. Students discussed strategies they use to edit their work, including the use of spell checker in Microsoft Word. The instructor introduced the EDIT mnemonic and strategy and explained the benefits of using the strategy.
2	3	The instructor introduced the first two steps of the EDIT strategy (i.e., "Examine your first draft," and "Do a SPELL Check"). Students learned how to use spellcheck to identify errors in a Microsoft Word document and used the following procedure to correct errors. First, check to see if spellcheck suggested the correct word. If not, sound out the incorrectly spelled word, change the spelling, and run the spellchecker again. If the correct spelling is still not available, use another word that has the same meaning as the incorrectly spelled word. Students were instructed to use the headphones and "speak" function Microsoft Word during the SPELL steps to have each sentence read aloud beginning at the end of the passage and moving through sentences from the end of the text to the beginning of the text. As students listen to each sentence they are to complete the rest of the SPELL steps (i.e. pass over the document, express each sentence, look for homophone errors, and look for typos). Students learned to save their work on a USB memory stick.
3	1	Students reviewed the previous two steps of the EDIT strategy (i.e., Examine your first draft, Do a SPELL Check) and graphed their graded work from the previous lesson. The instructor introduced common types of writing errors using the COPS mnemonic (i.e., Capitalization errors, Overall appearance errors, Punctuation errors, or Substance errors). The instructor used think-alouds to model the COPS steps, and students practiced with instructor guidance. At the end of the lesson, the instructor introduced the last step of the EDIT strategy (i.e., Correcting typos and running the spell checker once more). Students practiced saving their work on their USB memory sticks.
4	3	Students reviewed all steps of the EDIT strategy, including the SPELL and COPS mnemonics. Students then practiced using the EDIT strategy on electronic passages under the guidance of the instructor. The instructor provided each student individually with corrective feedback immediately after they completed the passage. Students then completed passages independently.

The type of editing errors addressed in the EDIT Strategy instruction included: spelling (including homophones), capitalization, overall appearance, punctuation, and substantive errors. For this investigation the EDIT Strategy was adapted by adding the use of the universal design features in Microsoft Word, such as the text to speech (i.e. "speak" function) and the use of headphones. An adapted graphic organizer was used in each lesson that depicted the strategy steps.

Two staff members of the postsecondary program were trained to collect treatment integrity data for each session. The first author provided a 30 min training to the staff members. The first author explained each step of the lesson and showed the staff members where each step was aligned with the respective item on the treatment integrity rating sheet. Mastery of training was determined by the first author based on the staff members' correct responses (e.g. all responses 100% correct) to the first author's questions concerning the lesson scripts and corresponding treatment integrity rating components. For instance, for the treatment integrity item "instructor provided advance organizer" the first author would ask the staff members to "describe an example from the script of what the instructor would say in order to provide the advance organizer." During the EDIT Strategy intervention sessions, the staff members were provided a copy of the instructor script and a list of consecutive steps that were to be com-

pleted for each respective lesson. Two staff members collected treatment integrity for six of the eight EDIT Strategy sessions. For the first and seventh session one rater collected treatment integrity due to rater absence, and the treatment integrity checklists indicated 100% fidelity for each session. For the remaining six sessions where treatment integrity was collected via both raters, both raters had 100% agreement and indicated 100% fidelity for each session.

Control group intervention. Participants in the control group who did not receive EDIT Strategy instruction participated in Science instruction in a large group format at the same time EDIT Strategy instruction was delivered. All participants regularly attended classes delineated in their postsecondary program throughout the day, five days a week. These classes pertained to transition and academic instruction (e.g., finance, career instruction).

Dependent variable EDIT Strategy scoring keys. Pre-, posttest, and maintenance prompts were all scored using the EDIT Strategy scoring keys. With regard to the edit prompts, Hughes et al. (2010) pre- and posttest prompts were adapted from the original EDIT Strategy testing materials provided in the manual. This investigation employed pre- and posttest prompts that had been adapted to not exceed the third-grade range in reading and that each included 30 total editing errors (i.e., six respective examples of spelling, capitalization, overall appearance, punctuation, and substance). The two adapted pretest prompts pertained to two different topics. The first prompt was entitled "Giant Panda" and pertained to characteristics of Giant Pandas. The second prompt was entitled "California Redwood" and pertained to facts about California Redwoods.

The pre- and posttests and maintenance prompt were all scored using respective EDIT Strategy scoring keys. The "California Redwood" and "Giant Panda" EDIT Strategy scoring keys each contained answers for the 30 editing errors for each respective prompt. The possible Total Score ranged from 0 to 30. There were six editing error examples for each edit error type (i.e., spelling, capitalization, overall appearance, punctuation, and substance). Possible scores for each editing type ranged from 0-to-6. As noted earlier, specific editing error types for spelling included two homophones and four incorrectly spelled words. Capitalization errors pertained to the beginning of a sentence or proper nouns. Overall appearance errors included additional spacing or omitted spacing between sentences and paragraphs. Substance errors pertained to missing subjects and articles.

A maintenance prompt was created by following the format of the EDIT Strategy manual original prompts. The maintenance prompt was written at the 2.3 grade level using Flesh-Kincaid and included 25 errors (i.e., six spelling errors, five capitalization, four overall appearance, five punctuation, and five substance). The prompt was a narrative passage about an adolescent named "Jake" who compared the advantages of driving different types of passenger vehicles. The maintenance prompt EDIT Strategy scoring key contained correct answers for the 25 errors with a possible Total Score that ranged from 0-to-25, and a respective range of scores (i.e. spelling 0-to-6, capitalization 0-to-5, overall appearance 0-to-4, punctuation 0-to-5, and substance 0-to-5).

Data collection. One week before EDIT Strategy instruction began all participants were administered a pretest (i.e., counter-balanced "California Redwood" and "Giant Panda" prompts) in a large group setting, in a computer lab. One week following the end of EDIT Strategy instruction, a posttest was administered (i.e., counter-balanced "California Redwood" and "Giant Panda" prompts) to all participants. The participants in the treatment and control groups completed a maintenance test two weeks following completion of the posttest.

Two graduate students enrolled in the College of Education at the Midwestern University where the study was conducted were trained by the first author in completing EDIT Strategy scoring keys. The one-hour training consisted of the first author providing the raters with examples of "fabricated samples" of completed edit prompts and the respective scoring keys. The first author reviewed the samples with the raters. Each rater scored the completed samples using the EDIT Scoring Keys. Raters' fidelity of scoring was achieved when the raters' scores were 100% correct and

when there was a 100% agreement between the raters.

Once the raters were trained they proceeded to score all completed prompts. The raters were blind with regard to whether completed prompts they were scoring were completed by treatment or control participants. The raters also did not know if the prompts were pre-, posttest, or maintenance prompts. All completed prompts were scored by these two raters who had previous experience in administering and evaluating assessment materials.

Data Analysis

Previous experimental group studies pertaining to the EDIT Strategy yielded Cohen's *d* effect sizes for EDIT Total Errors corrected as .84 and 1.01 (Woods-Groves et al., 2017; Woods-Groves et al., 2015). A power analysis was conducted using G power (Faul et al., 2007) with an effect size of .80 (based on previous EDIT studies' results) and an alpha of .05. G power results indicated a minimal sample size for two groups of 15 would be adequate ($N\_14.6429 - N\_15$). The results from the raters' completed respective Scoring Keys for the pretest and posttest prompts and the maintenance prompt were analyzed via SPSS 23 (2016). Bivariate correlations between raters' results were conducted. A series of ANOVA and analysis of covariance (ANCOVAs) with the pretest as a covariate were conducted with the average of the raters' results for the Scoring keys for pretests, posttests, and maintenance. Effect sizes were calculated via Cohen's *d* for all analyses. Cohen's (1988) criteria were applied. Effect sizes of $<.2$ were determined to be small, while results of $<.5$ were considered medium, and results of $>.8$ were considered large.

Results

Treatment Integrity and Inter-Rater Reliability

Treatment integrity checklists were completed for each of the eight EDIT Strategy lessons. There was 100% compliance with all the steps being followed for each of the eight lessons conducted. The mean from the two raters was calculated for each aspect of the EDIT Strategy scoring keys (i.e., pre-/posttests and maintenance). Inter-rater reliability for the raters' scores were compared via bivariate correlations for the pre-/posttests, and maintenance. The range and median Pearson product moment correlations for the Total EDIT score and each of the five editing error types included the following: (a).82 to .99 (Mdn = .96) for the pretests; (b) .89 to .99 (Mdn = .96) for the posttests; and (c) .99 to 1.00 (Mdn = .94) for the maintenance.

EDIT Strategy scoring key. The EDIT Strategy scoring key results for pretests for the control and treatment groups were examined via a series of ANOVAs. The average of the raters' scores for the EDIT Strategy scoring keys revealed no significant results when the treatment and control groups were compared for the pretest Total EDIT Errors corrected and five error types. The posttest EDIT Strategy scoring key results for posttests for the treatment and control groups were compared. The average of the raters' EDIT Strategy scoring keys for treatment and control groups was examined via ANCOVAs with the pretests as a covariate. The posttest Total EDIT Errors corrected revealed a significant positive difference for the treatment group when compared to the control group $F(2, 15) = 15.175$, $p = .002$ with a large effect size $d = 1.38$. An examination of the posttest specific editing error types revealed significant positive differences for spelling, punctuation, and substance for the treatment group when compared to the control group. No significant results were found for the error types overall appearance and capitalization. Pre- and posttest results are depicted in Table 2.

Maintenance. Two weeks following the posttest the students were given an EDIT Strategy electronic passage in the same format as the pre- and posttest passages. The setting was two computer labs at the university. Students in the treatment group completed the passage in a separate computer lab than the students in the control group. All the students were provided with a desktop PC and Microsoft Word to access the passage. The instructor provided a brief review of the EDIT Strategy for the students who were taught the strategy. Both groups were instructed to find and correct all editing errors in the passage. Two raters previously trained in how to score

TABLE 2

EDIT Strategy Assessments Pre- and Posttests Results

Pre/Post Test	*Total Errors Corrected*	*Spelling*	*Capitalization*	*Overall App*	*Punctuation*	*Substance*
C group (8)	17.88* (4.26)	4.88* (1.25)	5.13* (0.99)	4.56* (1.18)	2.63* (1.99)	0.50* (0.71)
T group (8)	16.31* (2.45)	5.00* (0.71)	5.31* (0.88)	4.81* (1.25)	1.06* (1.05)	0.13* (0.35)
Cohen's *d*	.45	.12	.19	.21	.99	.66
ANOVA	F (1,15) = .810	F (1,15)= .061	F (1,15) = .159	F (1,15) = .169	F (1,15) = 3.841	F (1,15) = 1.800
	$p = .383^{ns}$	$p = .809^{ns}$	$p = .696^{ns}$	$p = .687^{ns}$	$p = .070^{ns}$	$p = .201^{ns}$
Posttest						
C group (8)	16.94* (5.05)	4.75* (1.16)	5.06* (1.02)	4.00* (1.51)	2.25* (2.12)	0.81* (1.39)
T group (8)	23.81* (4.88)	5.88* (0.35)	4.38* (1.85)	4.88* (1.43)	5.25* (1.00)	3.19* (1.89)
Cohen's *d*	1.38	1.32	.46	.59	1.81	1.43
ANCOVA	F (1,14) =15.175	F (1,14) = 12.773	F (1,14) = .733	F (1,14) = 1.667	F (1,14) = 17.297	F (1,14) = 15.138
	$p = .002^{**}$	$p = .003^{**}$	$p = .407^{ns}$	$p = .219^{ns}$	$p = .001^{**}$	$p = .002^{**}$

Note. * Denotes mean values, C group (8) = number of control group participants, T group (8) = number of treatment group participants, Standard deviations are provided in parentheses. Overall App = Overall Appearance. ^{ns} = non-significant. ** Denotes significant. ES = Effect size, Cohen's *d*.

passages using the EDIT Scoring keys scored the students' responses. The average of the two raters' Maintenance EDIT Scoring Key results were compared for the treatment and control groups via an ANCOVA with the pretest results as a covariate. Results revealed a significant difference in favor of the treatment group for the EDIT Total Score group $F(1, 14) = 5.215$, $p = .040$ with a large effect size $d = .93$, however, no significant results were found for specific error types when the treatment and control groups were compared. The maintenance results including means, standard deviations, ANCOVA, and effect sizes are depicted in Table 3.

Discussion

When college students with IDD enter postsecondary programs at IHEs they are investing their time and financial resources. It is essential that students with IDD who have existing difficulties in the writing process including editing and revising within digital environments are provided with effective instruction within the IHE setting. While there is evidence of the positive effect of cognitive strategy instruction in improving writing skills for elementary and secondary learners with disabilities, there is a need to investigate the efficacy of writing strategies with postsecondary learners with IDD.

The purpose of this investigation was to further examine the use of the EDIT Strategy with postsecondary learners enrolled in a two-year college program for individuals with IDD. The first research question we investigated pertained to: Will students who were taught the EDIT Strategy significantly improve their skill in identifying and correcting editing errors within electronic documents when compared to the control group? Results from this study supported the use of the EDIT Strategy with the students who were taught the strategy, significantly out-performing students in the control group in the number of Total Editing Errors corrected, yielding a large effect size, $d = 1.38$. This finding was comparable to the two previous experimental group studies conducted by Woods-Groves and colleagues with postsecondary students with IDD ($n = 34$, across both studies) where effect sizes for Total Editing Errors corrected ranged

TABLE 3

Maintenance Probe: Treatment/Control Groups for 2 Weeks Following EDIT Strategy Instruction

Administration	*Total Errors Corrected*	*Spelling*	*Capitalization*	*Overall App*	*Punctuation*	*Substance*
MP 2 Weeks						
C group (8)	15.63* (4.11)	5.63*(.52)	4.63* (0.52)	1.81* (1.13)	2.69* (2.05)	0.88* (1.13)
T group (8)	19.31* (3.76)	6.00*(0.00)	4.81* (0.53)	2.38* (1.09)	3.31* (1.33)	2.81* (2.14)
Cohen's d	.93	1.01	.34	.51	.36	1.13
ANCOVA	F (1,14) = 5.215	F (1,14) = 3.987	F (1,14) = .446	F (1,14) = .795	F (1,14) = 2.356	F (1,14) = 4.121
	$p = .040^{**}$	$p = .067^{ns}$	$p = .516^{ns}$	$p = .389^{ns}$	$p = .149^{ns}$	$p = .063^{ns}$

Note. * Denotes mean values, C group (8) = number of control group participants, T group (8) = number of treatment group participants, Standard deviations are provided in parentheses. Overall App = Overall Appearance. ^{ns} = non-significant. ** Denotes significant. ES = Effect size, Cohen's d. MP = Maintenance Probe.

from d = .84 to 1.01 (Woods-Groves et al., 2017, 2015).

In the current investigation students received 6 hr. and 40 min of instruction. Positive effects were found despite the reduction in instructional time from the reported 13.3 hr. from Woods-Groves (2015) and 8.25 hr. from Woods-Groves (2017). Adaptations to the EDIT Strategy instruction included the use of text to speech and headphones during the revising process and eliminating one SPELL Check session and one COPS session from the reported number of sessions in Woods-Groves (2017). The reduction in instructional time is important to note given the need to identify effective yet usable and feasible instructional strategies within authentic IHE settings.

The second research question investigated was: Will students who were taught the EDIT Strategy correct a significantly higher number of error types (i.e., spelling, capitalization, overall appearance, punctuation, and substance) when compared to the control group? In this investigation we found a significant difference in the treatment groups' number of spelling, punctuation, and substance errors corrected when compared to the control group, but no significant differences in overall appearance and capitalization errors corrected. When these results were compared with the two previous postsecondary group EDIT Strategy studies, commonalities were revealed for some error types, while disparate results were found for others. In all three postsecondary studies students who were taught the strategy corrected a significantly higher number of punctuation errors with effect sizes that ranged from d = .96 to 1.81 with no significant effect found for capitalization errors. However, only one study (i.e., Woods-Groves, 2015) reported significant effects for overall appearance errors corrected. Two studies (i.e. the current investigation and Woods-Groves, 2017) revealed significant effects for spelling errors (d = .71 to 1.32) and substance errors (d = 1.41 to 1.66). It is important to note that while the instructional time was shortened in the current investigation, a significant difference and large effect size was found for the correction of substance errors, which is a more complicated revising skill. The third research question pertained to: If students who were taught the strategy

would retain their posttest skill level two weeks following the end of instruction? The maintenance probe administered two weeks following the posttest revealed that students in the treatment group corrected a significantly high number of total errors, but not respective error types when compared to the control group. Differences in the mean scores and effect sizes for the treatment group indicate an elevated number of error types were corrected when compared to the control group, however these differences were not significant. The two previous postsecondary IDD studies indicated that students who were taught the strategy significantly outperformed students in the control group in total errors corrected and in correcting error types in one of the two areas where they previously excelled 12 and 11 weeks respectively following posttest.

Limitations and Future Research

There were five limitations noted in this investigation. The first limitation pertains to the fact that we did not see a significant improvement in the correction of all editing error types when treatment and control groups were compared. In addition, students in the treatment group did not retain their posttest level of performance when tested two weeks later. This could be due to an instructional error where the number and focus of sessions may need to be increased or improved in areas (e.g., frequency of corrective feedback in guided practice). It could be due to a flaw in our dependent measure, the maintenance probe. While the pre- and posttest prompts each had 6 errors for each of the five error types, the maintenance probe only afforded students 25 error correction opportunities (i.e., six spelling errors, five capitalization, four overall appearance, five punctuation, and five substance). There may be a restriction in range with regard to the instances of error types in the maintenance probe used for this investigation. The second limitation was that students were not able to apply their editing skills to correcting their own work. Due to time constraints and the multi-faceted mnemonic steps taught in the strategy we were not able to have students practice their editing skills with their own written products. Future studies could perhaps embed an extension activity following independent practice that would have students generalize the editing skills they learn in each lesson to their own written work. A necessary next step in examining the EDIT Strategy is for the intervention to be used by individuals to edit their own work. The third limitation was that while we were able to examine the use of the EDIT Strategy in an authentic IHE setting, instructional settings, such as one-to-one tutoring, or small group instruction within an IHE inclusive classroom should be examined in future studies. The fourth limitation pertained to the use of a coin flip to assign participants to control or treatment groups. The use of a coin flip for assignment could result in an imbalance in participants with similar attributes being over assigned to one of the two groups (Kang et al., 2008). In order to address this limitation participants were stratified based on their standardized achievement scores (i.e., WJII Total Scores) before being assigned via coin flip. While there still could be an imbalance in participant assignment, stratification was one way to aid in the random assignment procedure (Kernan et al., 1999). The fifth and final limitation pertained to the fact that social validity data were not collected in this investigation concerning the students' perceptions of the EDIT Strategy, including the usability and feasibility of using the strategy in college settings. It is important to gather social validity information when conducting intervention studies in authentic settings to assess attitudes and views of students who use the strategy or methods. Social validity information can inform the further development of an intervention (Carroll & St. Peter, 2014). Future studies should include a metric to gather information from students and instructors concerning the use of the strategy.

Implications for Practice

Requiring college students with IDD who have difficulty in written expression to complete writing compositions with computers or tablets without further technological guidance is a disservice to the students. Not providing students with IDD support in accessing technology for writing can be construed as a

missed opportunity for teaching students to access universal design features of existing writing programs, such as spell check, text to speech, highlighting functions, and use of a dictionary or thesaurus. Cognitive strategy instruction that pertains to writing and revising in digital environments may afford postsecondary students with IDD an effective support to improve their performance in constructing and revising written text. To date, there have been four experimental investigations of the EDIT Strategy, one with upper elementary students with LD and three with postsecondary learners with IDD. Each study has supported the use of the EDIT Strategy in improving the editing skills of students who were taught the strategy. While empirical support is beginning to build, it is imperative that effective instructional practices be identified and examined for their use with young adults with IDD in authentic IHE settings.

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