Learning Disabilities: A Contemporary Journal 18(1), 27-47, 2020

Teacher Implementation of a Technology-Based Intervention for Writing

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Various technology-based interventions exist to support writing for students with learning disabilities (LD). However, it is not enough to simply provide access to technology. How it is implemented by teachers may affect student outcomes. In this study, three special education teachers used a technology-based graphic organizer (TBGO) with embedded self-regulated strategies and technology supports to improve the persuasive paragraph writing of 43 6th-8th grade students with LD. Teachers followed scripted lesson plans when delivering instruction. Quality of their instruction or process fidelity while implementing a technology-based intervention was determined. Students wrote a paragraph in response to a persuasive prompt using a Microsoft Word document at pretest, using TBGO at posttest with TBGO, and using a Microsoft Word document at posttest without TBGO. There were significant differences in the number of words, transition words, and essay parts measures between pretest and posttest with TBGO as well as between pretest and posttest without TBGO. Gain scores on the essay parts measure showed no correlation with the students' typing rate. However, there was a significant correlation found between those gain scores and teachers' process fidelity scores. Differences between teachers' implementation along with practical implications for the integration of technology tools in writing instruction are discussed.

Keywords: **Technology-Based Graphic Organizer, Self-Regulated Strategy Instruction, Writing, Learning Disabilities**

Introduction

Writing is a complex skill that requires many strategic actions and higher-order thinking (Mason et al., 2011). It can be broken into the following sub-skills: planning, idea generation, idea organization, revising and editing (Flower & Hayes, 1997). Based on the most recent NAEP report, only 28% of fourth-graders and 27% of eighth- and twelfth-grade students are writing at or above the *Proficient* level (National Center for Education Statistics, 2017). The need to support writing performance is exacerbated for students with learning disabilities (LD) who often struggle to master those sub-skills. Among students with disabilities, only one out of 20 shows

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adequate writing performance (Graham & Hebert, 2011). A recent meta-analysis comparing the writing characteristics of students with LD to their typically achieving peers revealed that students with LD perform lower on major writing outcomes including quality, organization, vocabulary, sentence fluency, conventions of spelling, grammar, handwriting, genre elements, output, and motivation (Graham et al., 2017). Further, poor writers experience more difficulties with executive functioning skills including the ability to think flexibly and to self-regulate throughout the process (Hooper et. al., 2002). In addition to the complexity of the writing process in general, persuasive writing poses added challenges. Persuasive essay parts are considered difficult for students to understand and produce (Gillespie et al., 2013) as the persuasive writing genre requires students to consider different perspectives and to generate salient reasons to support their opinions. Nevertheless, there are research-based practices and varied instructional approaches to support students' writing outcomes.

Writing Interventions to Support Students With Disabilities

Graham and Perin (2007) conducted a meta-analysis to identify effective writing interventions for students with disabilities. Based on the review of 123 articles, eleven practices were identified: (a) strategy instruction, (b) summarization, (c) peer assistance, (d) setting product goals, (e) word processing, (f) sentence combining, (g) inquiry, (h) prewriting activity, (i) process writing approach, (j) study of models, and (k) grammar instruction. Similar interventions were found to be effective for students with LD (Gillespie & Graham, 2014). Specifically, across 42 studies, strategy instruction for writing yielded the highest effect size of 1.09 for improving the quality of writing for students with LD. Of the interventions that were categorized under strategy instruction, the self-regulated strategy development (SRSD) model yielded an even higher effect size of 1.33. Explicit strategy instruction, like that rooted in SRSD, is a critical component when teaching the process of writing. It includes scientifically validated steps critical for mastering an academic task including (1) develop background knowledge; (2) discuss it; (3) model it; (4) memorize it; (5) support it; (6) establish independent practice (Harris et al., 2008). These steps can be followed when using a technology-based intervention.

Technology and Writing

Evidence suggests that combining explicit strategy instruction with technology-based supports could be an effective approach to improving the quantity and quality of writing for students with LD (Evmenova & Regan, 2019; Morphy & Graham, 2012; Park et al., 2017). In an effort to provide instructional scaffolding of a complex persuasive writing task, technology-based graphic organizers (TBGOs) were developed (Evmenova & Regan, 2012). TBGOs support the various sub-skills of the writing process by guiding students with LD to select a writing prompt, generate ideas, organize the ideas, and develop sentences that result in a cohesive persuasive paragraph. The TBGO includes transition words so that students can show how their ideas connect in the paragraph. Students are also prompted to review and revise their written product. Finally, the TBGO has embedded strategies and supports including a mnemonic, self-regulated learning strategies, and technology-based supports. It is

a multifaceted technology-based intervention and therefore, its effective use by students requires explicit teacher modeling of the components.

When integrated into writing instruction for students with various abilities and needs, research indicates that elementary and middle school students' persuasive writing outcomes improve with the TBGO (e.g., Evmenova et al., 2016, Regan et al., 2017a, Boykin et al., 2019). Students with high incidence disabilities, those at-risk for school failure, English language learners, as well as typically achieving peers have shown gains in both the quantity and quality of their writing when using the TBGO. These findings corroborate literature reviews that provide summaries of other studies that affirm the potential of technology to support the writing process (e.g., Ciullo & Reutebach, 2013; Graham & Perin, 2007; Morphy & Graham, 2012). However, it is important to integrate technology in meaningful ways and to use it as part of a cohesive learning environment where explicit instruction is also incorporated (Hasselbring, 2010).

Implementing Technology-Based Interventions with Fidelity

Simply providing access to technology does not necessarily translate into its effective integration (Ertmer et al., 2012). It is important to ensure that students receive explicit instruction that includes modeling of how to use the technology effectively (Regan et al., 2019). The degree of explicitness can vary from student to student, as well as the number of opportunities and/or scaffolds provided for the learner. Implementation fidelity of technology-based interventions for writing is especially important when teachers are the primary interveners. Students' outcomes depend on accurate implementation (Boer et al., 2014). Teachers need to be prepared to focus on specific technology features in response to students' needs. For example, the teacher may need to provide explicit modeling of how to find a definition of a word in a web-based dictionary for a student with LD struggling with executive functioning skills (Rago, 2020).

Fidelity is one of the most important components of educational research. After the enactment of Quality Indicators in Special Education Research (e.g., Gersten et al., 2005), intervention studies attended to structural fidelity of implementation. Structural fidelity is a dimension of fidelity that is typically measured by a dichotomous checklist to determine whether the important components of an intervention are in fact delivered (Harn et al., 2013). When using technology-based interventions, this may include a technology tool functioning as intended and students having the knowledge and ability to access all of the technology features as intended. However, while structural fidelity provides information about whether an intervention is delivered as intended, it does not reveal enough information about the quality of implementation. Process fidelity focuses on how well or to what degree those important components of an intervention are delivered (Harn et al., 2013). Process fidelity for students with disabilities, in particular, should be characterized by explicit instruction and modeling throughout the writing process (for example). Students need to be taught not only how the technology works, but also when to use certain supports. Unfortunately, the dimension of process fidelity is largely not reported in the field of intervention research (Swanson et al., 2013).

Previous investigations of student use of the TBGO have explored the degree of explicit instruction delivered by teacher participants across varied settings (e.g., social studies classrooms, Regan et al., 2019). Despite strong evidence for structural fidelity across those studies, the explicit instructional skills of teachers who have taught students to use the TBGO are vastly different. Does this element of process fidelity relate at all to student outcomes? In one specific study, quality of teacher implementation, or process fidelity was measured using descriptive observational data from video recordings of TBGO instruction and by a researcher-developed evaluation rubric known as the RIVER-R (Research InterVention Effectiveness Rating). The RIVER-R included three constructs that represented quality TBGO instruction: engaging instruction, student-centred learning, and effective instruction (see Regan et al., 2017b for further description). The Regan et al. (2017b) study included seventeen struggling writers from a low-performing urban middle school who participated in a multiple baseline single case study across three classroom settings: general education classroom, self-contained, and a co-taught class. Three teachers instructed their students to create persuasive writing responses using a TBGO. Following instruction, student writing from all three classes showed an increased number of words, number of sentences, number of transition words, and higher holistic writing quality score. In addition, students were able to maintain a level above their baseline during the maintenance phase when writing without the TBGO. Despite overall improvements, quality scores of teachers' implementation of the technology-based writing intervention from the RIVER-R indicated varying average scores from high to very low. Although no conclusion about the relationship between teachers' quality of implementation and students' gains were possible since students' characteristics and classroom contexts were quite varied across participating settings, results do suggest that more research is needed to understand the role of teachers' instruction in the effective implementation of technology-based interventions and improvements of student writing.

The current study aimed to explore the implementation of a technology-based intervention for writing by three special education teachers in order to guide the future use of TBGOs. The following research questions were answered: (1) Does the number of words, transition words, and essay parts in a persuasive paragraph improve after students with LD use a TBGO with embedded self-regulated strategies and technology supports for writing?; (2) Do students with LD maintain their gains after the TBGO is removed?; (3) Is there a relationship between gains in the number of essay parts at both posttest with TBGO and posttest without TBGO and students' typing rate?; and (4) Is there a relationship between gains in the number of essay parts at both posttest with TBGO and posttest without TBGO and the process fidelity of implementation by special education teachers?

Method

One group pretest-posttest with TBGO design was used in this study in effort to accommodate participating teachers' requests to allow all students access to the writing intervention at the same time. While a one group pretest-posttest is the weakest, pre-experimental design, it allowed researchers to determine the potential of the intervention for a specific population of students with LD and to further develop the guidelines for effective and feasible TBGO implementation (Marsden &

Torgerson, 2012). In addition to measuring writing performance from one group of students at pretest and posttest with the TBGO, posttest without the TBGO was added. The latter was conducted one week after the posttest with the TBGO in order to explore students' writing outcomes after the TBGO was removed.

Setting

This study took place in a low-performing middle school within a large metropolitan school district in the mid-Atlantic region of the United States. At the time of the study, 1,435 students were enrolled in the school across 6th-8th grade levels. There were 52% male and 48% female students. The majority of students were Hispanic (57%), Asian (19%), African-American (12%), white (10%), and other (2%). More than 75% of the students received free and reduced lunch. Almost 17% of students received special education services, while almost 36% were English Language Learners. Students from eight self-contained classes for students with high-incidence disabilities in grades 6th-8th participated in this study.

Student Participants

All students in the eight classes received the intervention, but only those who provided assent/parental consent were included in the data analysis. Overall, 43 students participated in the study, including 15 6th-graders, 17 7th-graders, and 11 8th-graders. All students were classified as having a learning disability as their primary disability. In addition, six students were diagnosed with secondary disabilities including ADHD, speech impairment, autism, and/or orthopedic impairments. Thirty seven percent of students were female and 63% were male. The average age was 12.14 years (*SD* = 0.97; range 11-14). In terms of ethnicity, 82% of students were Hispanic, 9% - African American, 7% - Asian, and 2% - Caucasian. Students had a mean Full Scale IQ score of 88.85 (*SD* = 8.99; range 71 – 115) on the Wechsler Intelligence Scale for Children. Their reading score on the annual standardized achievement test was 350.29 (*SD* = 44.68; range 292 – 473). The vast majority of students were also English Language Learners (88%). Their average WIDA scale score was 357.71 out of 600 (*SD* = 13.80; range 328 – 384). Their WIDA proficiency level was 4.12 out of 6 (*SD* = 0.68; range 3.0 – 5.7) indicating that most students were at the expanding English language proficiency level. Most students had a writing goal on their IEP (95.3%) including composing/editing (41.9%); paragraph/writing (16.3%); writing/editing (11.6%); paragraph/editing (11.6%); multi paragraph essay/editing (11.6%); and structure (2.3%). Almost 19% of student IEPs contained a behavioral goal, including those that addressed anxiety, peer interactions, attention, coping skills, organization, and self-advocacy.

Teachers

Three teachers implemented the writing intervention in order to support their students' persuasive writing. All were female Caucasians with an average age of 35 years old. Teacher A held a Master's degree in education and had 2.5 years of teaching experience in special education. She taught 6th-grade and used the TBGO in two self-contained classes. Teacher B held a Bachelor's degree in elementary education and had 6 years of teaching experience. She taught 7th grade and used the TBGO

in three self-contained classes. Teacher C held a Master's degree in management and had taught for 7 years. She taught 8th grade and used a TBGO in three self-contained classes. All three teachers were licensed to teach K-12 special education.

Independent Variable

Writing instruction in this study was based on the use of a technology-based graphic organizer (TBGO) and accompanying researcher-developed lesson plans. The TBGO was developed using a table-to-text feature in *Microsoft Word* (e.g., see Hughes et al., 2019 for a detailed description). Overall, the TBGO included five parts described below (see Figure 1):

1. Pick a goal is where students selected a goal for their paragraph from a drop-down menu to include (a) three reasons and one example; (b) three reasons and two examples; or (c) three reasons and three examples;
2. Fill out a table is where students brainstormed their ideas, organized them according to a mnemonic IDEAS (I=Identify your opinion, D=Determine three reasons, E=Elaborate with examples, A=Add transition words as you go, and S=Summarize), wrote complete sentences, and checked their work;
3. Copy is where students copied their complete sentences from the orange sentences box on the first page;
4. Paste is where students pasted their complete sentences into another orange box on the second page and edited their sentences using the text-to-speech feature built-into *Microsoft Word*; and
5. Self-evaluate is where students evaluate their own writing by responding to questions such as: how many words do I have in my essay?; How many sentences do I have in my essay?; How many reasons do I have in my essay?; how many examples do I have in my essay?; Do all my sentences make sense? How do I feel about my essay? Students also set their next writing goal in Part 5 and provide feedback to each other.

The following self-regulated learning strategies were embedded into the TBGO: (a) goal setting, (b) self-instruction, (c) self-monitoring, and (d) self-evaluation. In addition, several technology-based supports were embedded to support students with LD. Those included (a) audio comments and hover over text hints that would clarify parts in the TBGO; (b) drop-down menus with different transition word options to begin a sentence; (c) table-to-text feature to break down the paragraph writing into a manageable task of writing one sentence at a time; and (d) spell check and text-to-speech features to support students' writing and editing (e.g., misspelled words were underlined; students could highlight their paragraph, click on the Speak feature activated in *Microsoft Word* prior to the study, and listen to their paragraph read aloud).

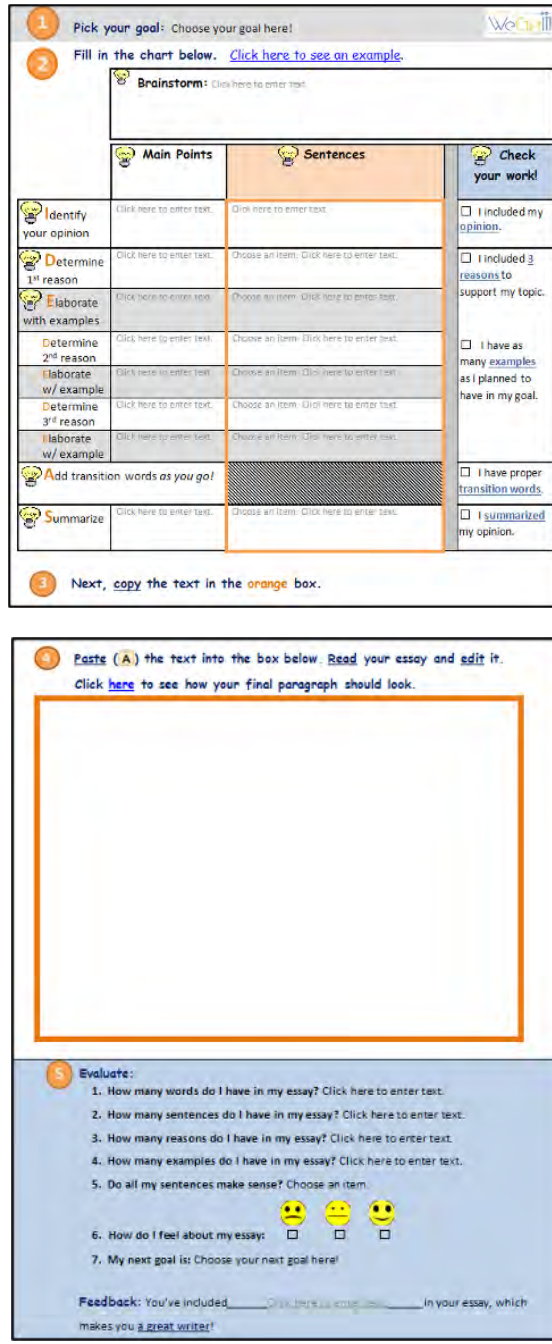

Figure 1. **Technology-based graphic organizer with embedded self-regulated strategies and technology supports.**

Materials

In addition to the TBGO, teachers received researcher-developed 4+1 scripted lesson plans and activities. These lessons followed the six steps of the explicit SRSD strategy instruction. Specifically, Lesson 1 focused on developing background knowledge (step 1). Specifically, the persuasive genre of writing and the IDEAS mnemonic were introduced. Students had an opportunity to identify different essay parts in an existing persuasive paragraph. Lesson 2 focused on the discussion of strategies (step 2) and introduced students to the importance of self-regulated learning strategies such as goal setting, self-monitoring, and self- evaluation. The teachers showed how the strategies were embedded in the TBGO. Students used a partially completed TBGO in Lesson 2 to explore its components. Lesson 3 offered step-by-step modeling (step 3) of how to complete the TBGO. During guided practice with the teacher, students went through all of the TBGO parts and collaboratively created a persuasive paragraph in response to a prompt. Teachers used both pre-recorded how-to-use TBGO demonstrations and scripted "think-out-loud" protocols to model how to use the TBGO. In Lesson 4, students had an opportunity to use the TBGO independently while the teacher assessed students' mastery of TBGO use via a mastery checklist and provided feedback to students, as needed (steps 4-7). After these four lessons, students were given at least five opportunities to write independently using the TBGO (steps 4-7). After independent practice with the TBGO, Lesson 5 was delivered to model how to write without a TBGO. Teachers demonstrated how to first establish a goal for writing (e.g., 3 reasons +1 example; 3 reasons +2 examples; or 3 reasons +3 examples), write the IDEAS mnemonic down the length of a blank piece of paper, create a bank of as many transition words as possible from memory, self-monitor and check off different essay parts, and evaluate one's writing. In a sense, students were asked to re-create the TBGO.

Throughout all lessons, teachers and students had folders with all required materials. In addition, teachers had access to all materials in electronic format on a flash drive. Teacher materials included scripted lesson plans, PowerPoint presentations for each lesson, copies of all student materials, a mastery checklist to assess students' ability to use the TBGO independently, as well as a procedural fidelity checklist for each lesson. Each fidelity checklist included the list of all the important components within the lesson plan that the teachers were required to explicitly teach and model (see Table 1).

Teachers also received a list of writing prompts validated by previous research with similar populations (e.g., Evmenova et al., 2016) to use during lessons as well as during independent practice. Each time, students were given two prompts and asked to choose one to write about. Student materials included an agenda for each lesson allowing students to check off the activities as they progressed through the lessons; an index card with the IDEAS strategy; a TBGO scavenger hunt, as well as several additional warm-up activities and exit tickets focused on mastery of the TBGO components.

All instructional and testing sessions were videotaped. Each teacher received a camera and a tripod, which were turned on at the beginning of each session. Each student received a flash drive on which they were asked to save their writing responses (whether they wrote using a *Microsoft Word* document or the TBGO in *Microsoft Word*).

Professional Development

Prior to the study, teachers participated in a 6-hour professional development (PD) session led by the researchers. The session was held at the teachers' school, during which they were introduced to the TBGO and all of the accompanying materials. Specifically, teachers explored the TBGO by writing an essay in response to a prompt "Should teachers use technology as part of their writing instruction?" They reviewed lesson plans and participated in a modified lesson study (Regan et al., 2016) teaching portions of TBGO lessons and receiving feedback from their colleagues. Finally, they examined all research components and raised any questions or concerns with the researchers. The researchers observed the teachers and provided feedback on all PD elements. Following the PD, teachers completed the self-evaluation on their understanding of the tool and lesson plans. The researchers observed.

Dependent Variables

Dependent variables in this study included student writing outcome data and teacher fidelity of implementation data. The number of words, transition words, and essay parts measures were used to determine changes in students' writing performance. These are common writing measures used in writing research (e.g., Gillespie & Graham, 2014).

Student Writing Outcomes

First, the number of words written per essay was counted. Word count feature of *Microsoft Word* was used to ensure consistency in scoring. In addition, the number of transition words was counted. Those included all of the options for transition words provided in the dropdown menu within the TBGO (e.g., first, also, in addition, for example, in conclusion, etc.) as well as any word (or short phrase) at the beginning of a sentence that represented a transition of thought or a connection to ideas from a previous sentence. Finally, the persuasive essay parts were evaluated using a rubric. Responses to a prompt were scored on a scale from 0 to 8. No essay parts written in complete sentences received a score of 0. A response received a score of 8 if it included a discrete topic sentence, three discrete reasons, at least two discrete examples, a discrete summary, at least two transition words used correctly, and a paragraph written in a logical sequence that strengthens the writer's argument.

Reliability of Scoring. All students' responses were scored by two raters to ensure the reliability of scoring. Raters, who were doctoral students with experience in special education and graduate research assistants affiliated with the research project, were trained by the second author to score using persuasive writing samples from previous research. In the present study, they rated all paragraphs independently. When discrepancies existed, raters met to resolve discrepancies which resulted in a final inter-rater agreement of 100% across all writing outcome measures.

Teacher Fidelity of Implementation

Both structural and process fidelity of implementation were measured. First, structural fidelity was calculated using the fidelity of implementation checklists. Researchers directly observed each participating teacher and checked if the required component was implemented within each lesson. Within each lesson, teachers were expected to ensure that (a) the technology was ready for students to use; (b) all neces-

sary materials were given to students; (c) the PowerPoint presentation was followed throughout the lesson; and (d) the teacher introduced the agenda and instructed students to check off completed items. In addition, teachers were asked to ensure that all warm-up and exit tickets were implemented as designed according to the script. Required steps specific to each lesson are summarized in Table 1. The number of components implemented was divided by the number of steps planned to calculate structural fidelity of TBGO implementation. Structural fidelity of implementation was analyzed across all participating teachers and classrooms and yielded high fidelity at 96.4% with scores ranging from 90% -100%.

Table 1. ***Components for the Structural Fidelity Implementation Specific to Each of Five Lessons***

Lesson 1	Lesson 2	Lesson 3	Lesson 4	Lesson 5
• Describes what it means to persuade • Introduces strategy IDEAS • Examines essay parts on a sample paragraph	• Introduces three self-regulated strategies for writing • Models and asks students to interact with partially completed TBGO	• Models completing TBGO with student input • Ask students for ideas for essay parts • Highlights support features in TBGO	• Provides review of TBGO • Instructs students to complete TBGO independently • Assesses mastery of TBGO	• Thinks-out-loud how to re-create components of TBGO • Models writing process without TBGO with student input

In addition to the structural fidelity, an observational rubric was developed to measure process fidelity or the instructional quality demonstrated by participating teachers while teaching students to use the TBGO. As stated earlier, the River-R: Research InterVention Effectiveness Rating – Rubric was aligned with the technology-based intervention and the existing lesson plans and focused on the three constructs: (a) effective teaching, (b) engaging instruction, and (c) student-centered learning. Such items as (1) behavior management, (2) reinforcement, (3) incidental teaching, and (4) materials management were elements of the effective teaching construct. Then, (5) teacher language/vocabulary, (6) pacing, and (7) enthusiasm were elements of the engaging instruction construct. Finally, (8) cultural relevance, (9) student engagement, and (10) active questioning items were part of the student-centered learning construct.

Psychometric properties of the RIVER-R were established prior to the current study (e.g., Regan et al., 2017b). First, operational definitions based on a review of related literature were developed for all 10 items in the rubric. Three content experts who were researchers familiar with the technology-based intervention and writing instruction reviewed all rubric items (e.g., Evmenova et al., 2016). In addition, interrater reliability of the RIVER-R was determined after applying the rubric to rate video recordings of two teachers' instructional lessons from previous research. Six independent raters who were principal investigators and/or graduate research assistants on the project were introduced to the instrument and all operational defini-

tions. They were then asked to independently watch two recordings and rate them using the RIVER-R. Cohen's kappa was calculated to determine inter-observer agreement across multiple observers. Cohen's kappa was significant for each of the two recordings: $k = 0.948$ and $k = 0.86$ indicating high reliability of the rubric.

In the present study, video recordings of each lesson from each participating teacher were obtained and scored using the RIVER-R. Each of the 10 items across three aforementioned constructs were rated on a 4-point scale from 0 (insufficient evidence) to 3 (high evidence). An example of the scoring rubric for one of the 10 items is presented in Figure 2. Scores for each item across constructs were summed for a total score. For each lesson, teachers could receive the total score of 29-30 demonstrating high quality implementation; 20-28 – medium quality implementation; 10-19 – low quality implementation; and 0-9 insufficient quality implementation. An average score across all the lessons per teacher was reported.

Engaging Instruction						
Measure	**Definition**	**High (3)**	**Medium (2)**	**Low (1)**	**Insufficient (0)**	**Score**
Enthusiasm	*The way in which a teacher physically and verbally displays instruction.*	• Teacher teaches from knowledge and not written plans • Teacher moves throughout the environment • Teacher uses inflections • Teacher has positive affect • Teacher displays high energy	• Teacher knows the lesson BUT reads from the PowerPoint affecting student engagement • Teacher uses flat tone to indicate disdain or disconnection • Teacher has a moderate to low energy level • Teacher remains in place and does not move throughout environment	• Teacher reads from the notes of the PowerPoint with no-preparation evident • Teacher has negative affect • Teacher has no energy	• None	

Figure 2. **Sample one item (out of 10 items) on the the River-R: Research InterVention Effectiveness Rating – Rubric (full rubric is available upon request).**

Reliability of Scoring. The first author rated 100% of recordings. Then, from a total of 25 videos, an independent rater watched 28% of the recordings (three videos from Teacher A; two from Teacher B; and two from Teacher C) and rated them using the RIVER-R. The independent rater was a doctoral student in special education unfamiliar with this study or research project who received training from the first author on the RIVER-R instrument. During the 2-hour training, a sample video was reviewed and scored together using the RIVER-R. The interobserver agreement between the researcher and an independent rater was determined using the total agreement formula by diving the smaller total by the larger total and multiplying by 100%. The interobserver agreement for teachers' process fidelity of implementation was 92%.

Procedures

After obtaining all necessary approvals from the university and the school system, assent/parental consent forms were distributed to the teachers, students, and their parents. Teachers received six hours of professional development and implemented the technology-based intervention for eight weeks during their English class periods. First, students were given a typing test to determine their typing rate. They were asked to take 1 min to re-type as much of a text passage as possible into a *Microsoft Word* document. Students were not excluded based on their typing rate. It was measured to explore possible correlations.

Then, a pretest was conducted to determine students' writing performance prior to the beginning of the study. During pretest, teachers followed the script to deliver the testing instructions. In all classes, students were given a choice of two prompts and were asked to write in response to one of the prompts for no longer than 30 min. Students typed their responses in a *Microsoft Word* document. Teachers did not provide any help or feedback during the pretest.

Following the pretest, four lessons were delivered in each of the classrooms based on the teachers' individual teaching schedules. Teacher A delivered instruction over 10 separate days (two days for Lesson 1; three - L2; two - L3; three – L4). Teacher B instructed for seven days (two days for Lesson 1; two – L2; two – L3; one – L4). Teacher C delivered instruction over six days (one day for Lesson 1; two – L2; one – L3; two – L4). On average across multiple days, Lesson 1 lasted 56.06 min; Lesson 2 – 93.72 min; Lesson 3 – 71.33 min; Lesson 4 – 93.56 min. During the final lesson, teachers observed the students and assessed their mastery in using the TBGO independently.

Post instruction, students had at least five opportunities to write independently using the TBGO. Students wrote twice a week in each of three classes. A posttest with TBGO was then conducted. During posttest with TBGO, teachers followed the script to deliver the testing instruction and did not provide help or feedback. Similar to the pretest, students were asked to choose one prompt from the two provided and were asked to use the TBGO to construct their persuasive response for no longer than 30min. Teachers did not provide any help or feedback during posttest with TBGO.

After posttest with TBGO, teachers delivered Lesson 5, in which they modeled how students can use what they have learned to write without the TBGO. Teachers used a scripted "think-out-loud" protocol to demonstrate how to use the IDEAS mnemonic and various self-regulated strategies without the TBGO. The students were also provided an opportunity to write without the TBGO independently. It took one instructional period for all teachers to deliver Lesson 5. On average, Lesson 5 lasted 40.59min.

One week after the posttest with TBGO, a posttest without the TBGO was conducted in each class to determine students' writing performance when the TBGO was removed. The posttest without the TBGO followed the same procedures as the pretest. While it was not mandatory, students could plan out their writing on a blank piece of paper before typing their responses in *Microsoft Word* document.

Data Analysis

To address Research Questions 1 and 2, descriptive statistics and a paired-sample *t*-test were used to determined differences between students' writing performance at pretest and posttest with TBGO as well as at pretest and posttest without TBGO across all dependent variables: number of words, number of transition words, and essay parts measure. In response to Research Questions 3 and 4, descriptives and frequencies were used to determine (a) students' gain scores for the essay parts measure between pretest and posttest with TBGO; (b) students' gain scores for the essay parts measure between pretest and posttest without TBGO; (c) students' typing rate; and (d) teachers' process fidelity of implementation scores. Then, Pearson cor-

relation was calculated to determine the relationship between the typing rate as well as teachers' process fidelity of implementation score from the River-R and the essay parts measure at posttest with TBGO and posttest without TBGO.

Results

Prior to the analysis, students across grade levels were compared on the IQ and WIDA English language proficiency levels to ensure that there were no differences that could have affected the overall results. One-way ANOVA showed no statistically significant differences between 6th-grade, 7th-grade, and 8th-grade students on their IQ scores $F(2,39) = .839$, $p = .442$. and WIDA scores $F(2,40) = 1.78$, $p = .183$.

Student Writing Outcomes

Means and standard deviations for the number of words, number of transition words, and essay parts measure at pretest, posttest with TBGO, and posttest without TBGO are reported in Table 2.

Table 2. ***Means and Standard Deviations for All Participants Across Dependent Variables and Testings***

	Pretest *M*(*SD*)	Posttest with TBGO *M*(*SD*)	Posttest Without TBGO *M*(*SD*)
Number of words	68.12 (42.43)	97.53 (40.40)**	82.45 (34.67)**
Number of transition words	0.14 (0.18)	4.33 (1.98)**	2.13 (1.98)**
Essay parts measure	2.17 (1.36)	3.83 (1.45)**	3.64 (1.50)**

Note. ** $p < 0.01$

Posttest with TBGO

As can be seen in Table 2, students included more words, more transition words, and more essay parts when they wrote using the TBGO at posttest with TBGO. Differences between pretest and posttest with TBGO were statistically significant for all student writing outcome measures. Paired-sample *t*-test for the number of words written was $t(42) = -5.28$, $p = .000$, for the number of transition words written – $t(42) = -14.05$, $p = .000$, for essay parts measure – $t(42) = -7.08$, $p = .000$.

Posttest without TBGO

Furthermore, when the TBGO was removed, students maintained their improvements. They wrote more words, more transition words, and included more essay parts than what they produced at pretest. Differences between pretest and posttest without TBGO were statistically significant for all dependent variables. A paired-sample *t*-test for the number of words written was $t(42) = -2.75$, $p = .009$; for the number of transition words written – $t(42) = -6.82$, $p = .000$; and for the essay parts measure –$t(42) = -5.35$, $p = .000$.