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The Effects of Four Multimedia Writing Strategy Programs on Secondary Students' Sentence, Paragraph, and Theme Writing

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ABSTRACT

This study involved a pretest-posttest control-group design in which four multimedia writing programs were tested with secondary students across a school year. These programs were based on strategic instruction and focused on the skills of writing complete sentences, paragraph writing, and theme writing. Measures included scores on practice activities and quizzes, time spent, knowledge tests about writing skills, sentence-construction scores, complete sentences scores, planning scores, paragraph-organization scores, theme-organization scores, and satisfaction ratings. All of the students who used the multi-media writing programs met mastery on all of the practice activities, quizzes, and planning and writing samples. Significant and substantial differences were found between the posttest scores of the writing students and students who received other academic instruction, as well as between the writing students' posttest scores and posttest scores of a normative comparison group.

Students who reach the secondary grades with writing deficits present a difficult challenge for educators because these students are not able to respond to the basic writing requirements of their required courses. For example, the secondary curriculum and national and state standards require students to be able to respond to writing assignments with complete sentences containing proper grammar and mechanics as well as with well-organized paragraphs and essays in several genres (e.g., Deshler et al., 2006; Putnam et al., 1992; Schumaker & Deshler, 1984; Young & Courtad, 2016; National Governors Association Center for Best Practices & Council of Chief State School Officers, 2010a &, 2010b). In 48 states, students are required to take minimal writing competency exams, and in 12 states they must pass these exams in order to graduate from high school (Gewertz, 2017). Additionally, teaching students all the required writing skills is not part of the secondary curriculum, which is focused on analyzing subject-area content (Deshler & Schumaker, 2006). English courses, where writing was traditionally taught, primarily focus on the instruction of literature. Moreover, secondary subject-area teachers do not feel efficacious about changing students' writing and are less likely to make adaptations for students with writing deficits (Poch et al., 2019). According to a seminal study, students with writing deficits (low achievers and students with learning disabilities) have been shown not to acquire writing skills across the secondary grades (e.g., Warner et al., 1980). To add to this challenge, the group of students who might be considered "struggling writers" is not small. Indeed, according to the latest data from the National Assessment of Educational Progress, only 33% of 8th graders earn scores at the proficient level or above on the writing competency test (they earn a mean score of 156 out of 300), and students representing minority populations score even lower (National Center for Education Statistics, 2008, 2012). In other words, thousands of students, in fact a majority of students in some areas, might be considered struggling writers.

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Not surprisingly, given this history of poor results, the National Commission on Writing (2006) called for writing instruction to be the centerpiece of the curriculum to be taught in all courses at all grade levels. Unfortunately, teachers and researchers have reported that little time is spent writing by students. Elementary students, for example, spend about 20 min. per day writing (Cutler & Graham, 2008). Middle-school teachers reported spending about 15 min. per day teaching writing (Gilbert & Graham, 2010), and, in the higher grades, teachers report even less time spent on writing instruction (Kiuhara et al., 2009). Of more than 8000 assignments gathered in secondary schools, Applebee & Langer (2011) found that only 19% represented extended writing of a paragraph or more. The rest represented copying from the teacher's presentation or filling in worksheets. Their class observations showed that only 7.7% of student time was spent writing. Teachers report using the process-writing approach for teaching writing; however, this is not the approach that has been found to produce positive effects for struggling writers and students with writing disabilities, which involves the teaching of explicit writing strategies (Gillespie & Graham, 2014; Graham & Perin, 2007a, 2007b; Swanson & Hoskyn, 1998; Swanson et al., 1999).

In point of fact, considerable research has been conducted to develop instructional methods for teaching writing skills. The large majority of the research studies that have been conducted have focused on teaching a single writing skill. Researchers have developed methods for teaching sentence writing (e.g., Datchuk, 2016, 2017; Datchuk & Kubina, 2017; Datchuk & Rodgers, 2018; Kline et al., 1991; Limpo & Alves, 2013; Pennington et al., 2018; Saddler, Asaro et al., 2008; Saddler, Behforooz et al., 2008; Saddler & Graham, 2005), editing /revising skills (McNaughton et al., 1997; Reynolds et al., 1988; Schumaker et al., 1982), paragraph-writing skills (Moran, 1981), and essay writing skills (Ray et al., 2018) using live instruction. These researchers have shown that various methods (e.g., direct and explicit instruction, strategic instruction) can be used to teach these skills in an isolated way.

Indeed, strategic instruction (Deshler & Schumaker, 1988; Hock et al., 1993; Schumaker & Deshler, 2006; Tralli et al., 1996) has been one of the most successful methods used for teaching writing (Gillespie & Graham, 2014). This approach is based on the notion that expert learners invent and apply learning strategies to complete academic tasks and that struggling learners should be explicitly taught such strategies to improve their academic performance (Pressley et al., 1987; Pressley & McCormick, 2007).

Some researchers have utilized strategic instruction to teach students more than one writing skill. For example, Bui et al. (2006) created an instructional program for elementary students based on strategic instruction in which the Fundamentals of the Sentence Writing Strategy program (Schumaker & Sheldon, 1998) was implemented along with an adaptation of the Paragraph Writing Strategy program (Schumaker & Lyerla, 1991). Two classes were randomly selected to receive the strategy instruction, while three classes proceeded with instruction as usual. Results showed that only about 40% of the fifth graders' sentences were complete sentences at the beginning of the study. At the end of the study, the students who received the strategy instruction earned significantly higher scores on tests measuring complete sentences, complicated sentences, and paragraph organization than the students who received their regularly scheduled writing instruction.

Schmidt et al. (1988/89) also used strategic instruction to teach high-school students four writing strategies: the Sentence Writing Strategy (Schumaker & Sheldon, 1985), the Paragraph Writing Strategy (Schumaker & Lyerla, 1991), the Error Monitoring Strategy (Schumaker et al., 1982, 1985), and the Theme Writing Strategy (Schumaker, 2003). Schmidt et al. (1988/89) used a multiple-baseline across-skills design to show that, as each strategy was learned, the students generalized skills associated with the strategy to the writing assignments that they completed in their general education classes. Additionally, since the study lasted more than a year, they also showed that the students maintained their skills over the summer into the next school year and that the students gained an average of two grade levels on a standardized writing test (from grade 6.2 to 8.2) and earned higher average scores than their peers on the state writing competency exam.

These research results are encouraging; however, the instructional methods validated in these studies are not often used in today's schools. In general, secondary teachers have not been trained

to use these methods, and, as mentioned above, they may not perceive that their role is to remediate students' writing-skill deficits. Even if they are trained, they may not have the time to provide the required repetition with multiple practice attempts and the special types of feedback required by struggling learners to reach mastery on required skills. Nevertheless, a means needs to be devised for ensuring that students who reach the secondary grades with poor writing skills can indeed "catch up" with the requirements of the curriculum and state standards. Further, if national and state goals are to be met, these methods need to be readily available as well as effective.

One possible way of providing the needed writing instruction involves the use of computerized software that incorporates interactive multimedia programming. Multimedia can include a variety of media sources, including text, video, audio, animation, graphics, and interactive activities like quizzes and practice activities. It has several advantages. For example, multimedia can be used at a variety of times even when students are at home, it can be used to differentiate instruction for individuals, instructional fidelity is ensured, and mastery learning can be easily monitored by the computer on many skills. If the software is programmed well, students can use it relatively independently, and it can provide positive and corrective feedback to students in such a way that students' skills improve.

Indeed, interactive multimedia has been shown to be effective in teaching writing skills when students' use of the multimedia software is monitored by a teacher. For example, Schumaker et al. (2019) showed that a multimedia program (Schumaker & Sheldon, 2010) was effective in teaching Punctuation Strategies using a control-group design. With a similar design, Schumaker et al. (2019) showed that a multimedia program (Schumaker & Sheldon, 2009) could be used to teach Commas Strategies. In both studies, the researchers showed that secondary students with learning disabilities could not only learn and generalize the commas and punctuation skills to edit others' sentences and write their own sentences but that they could earn significantly higher scores than their nondisabled peers on writing tests.

Even more recently, Schumaker (2020) used a multimedia program (Schumaker, 2013) to teach sentence- and paragraph-writing skills to 18 secondary students including some with disabilities. By employing a multiple-baseline across-students design, Author showed that the students' complete sentence scores increased when they were taught the Sentence Writing Strategy, and their Paragraph Organization scores increased when they were taught the Paragraph Writing Strategy through the use of an interactive multimedia software program.

Nonetheless, because of recent research, the contributions of computer usage to writing performance might need further exploration before digital programs are recommended for use in writing instruction. Tate et al. (2019) conducted a study whereby they related students' prior use of computers and keyboarding activity to their scores on the 8th-grade version of the 2011 National Assessment of Educational Progress (NAEP). (This was the first version of the NAEP where computers were used in its administration.) Tate et al. found that students' self-reported prior use of computers for schoolwork and their frequency of keyboarding activities while taking the test were significantly related to their writing scores on the NAEP. These findings suggest that students' writing scores might be affected if students have prior experience with and are facile with computers. A controlled experiment seems warranted whereby some students are taught writing skills via computerized programs and other students are taught other academic skills through computerized programs (thus giving both groups practice with using computers), and writing tests are administered solely through paper and pencil methods.

To this end, the purpose of the current project was to test the effects of a comprehensive software package of sentence-, paragraph-, and theme-writing instruction against the effects of a comprehensive software package of instruction in other academic skills while controlling for the effects of practice with computer usage. The research questions were as follows.

(1) Is there a significant difference between the posttest scores of students who use the multimedia writing programs and the posttest scores of students who use other non-writing multimedia programs with regard to their knowledge of sentences, paragraphs, and themes?
(2) Is there a significant difference between the posttest scores of students who use the multimedia writing programs and the posttest scores of students who use other non-writing multimedia programs with regard to their skills associated with complete sentences, persuasive paragraph writing, narrative paragraph writing, persuasive theme writing, and narrative theme writing?
(3) Is there a significant difference between the posttest scores of students who use the multimedia writing programs and the posttest scores of normative comparison groups with regard to their skills associated with persuasive and narrative paragraph writing and persuasive theme writing?

Method

Participants

The total sample of experimental participants

Our organization's Institutional Review Board, the funding agency, and the school district reviewed and approved the procedures for protecting human subjects in this study. Youths were recruited through teachers of students with disabilities, teachers of English/Language Arts and reading courses, teachers of ELL courses, the Boys and Girls Club, Van Go, Inc. (a nonprofit organization providing services to high-needs and underserved youths), the therapeutic classroom at the county mental health center, Court Appointed Special Advocates, and religious organizations. At each physical location, a presentation was given about the project, and youths interested in improving their academic skills were encouraged to volunteer. Teachers and leaders at the targeted organizations were asked to encourage youths who were struggling academically and needing extra academic instruction to participate. Each youth took a written description of the study home to parents/guardians. Each volunteer and his/her parent/guardian signed an informed consent form.

Sixty-nine students volunteered. All students who volunteered were accepted; all of them met the criteria for acceptance in the study.[1] Half of the volunteers at each level of schooling (junior vs. senior high) were randomly selected for the "writing group" which received the multimedia writing interventions (n = 32); the other half (n = 37)[2] served in the alternate treatment group (hereafter referred to as the "academic-skills group"), which received the alternative academic interventions. (See the two left-hand columns of Table 1 for demographic information.) They were paid $10 per hour for their work plus $25 for taking the pretests, $25 for taking the posttests, and a $100 bonus for completing all their assigned work. The study took place outside of school hours during a full school year. Students took part according to their individual after-school and weekend schedules and parent availability to provide transportation.

The "Completers"

A subgroup of those students who completed all of the software programs assigned to them was formed within each of the experimental groups. (These students will hereafter be referred to as the "Completers.") These subgroups remained when some students left the study at the end of the first semester for a variety of reasons, including moving to another city or state, severe illness, lack of transportation, participating in a sport, and having to take a job to help support the family. The students who left the study (hereafter referred to as "half-completers" because they completed half of the software programs assigned to their group) took only a partial set of posttests (see the later explanation under "Measures"). In contrast, the completers completed all the software programs

[1]In order to be accepted, students had to meet both of these criteria when writing a paragraph: (a) less than 7 out of 8 sentences were complete sentences; and (b) the paragraph organization score was less than 80%.
[2]These final uneven numbers are a result of students dropping out of the study for a variety of reasons including transportation problems, serious health problems, a head injury, sports activities, and the need to work.

Table 1. Demographic data on experimental participants and the completers.

	All Experimental Participants		Completers	
Category	Writing Group	Academic-Skills Group	Writing Group	Academic-Skills Group
Total Number	32	37	27	32
Gender				
Male	19	24	16	19
Female	13	13	11	13
Average grade	8.8	9.1	8.9	8.9
IEP Plan	8	6	8	6
Ethnicity				
Caucasian	18	27	15	24
African American	4	5	3	5
Asian	4	2	4	1
Native American	2	2	2	2
Not reported	4	1	3	0
Mean reading score*	82.3	87.7	82.3	87.7
Mean math score*	77.9	85.6	77.9	85.3

*Score on the State Competency Exam

Table 2. Demographic data on the normative groups of students.

	Junior-High Students		Senior-High Students		
Category	Group 1 Grade 8	Group 2 Grade 8	Group 3 Grade 9	Group 4 Grade 12	Group 5 Grade 12
Total Number	20	16	20	21	21
Gender					
Male	9	6	3	5	9
Female	11	10	17	16	12
Active IEP Plan	4	6	4	3	2
Ethnicity					
Caucasian	14	9	16	18	20
African American	4	1	1	1	0
Asian	0	0	1	2	1
Native American	2	1	1	0	0
Other	0	5	0	0	0
Mean reading score*	83.9	88.2	87.6	83.2	85.7
Mean math score*	69.1	76.0	77.9	73.6	75.4

*Standard score on the State Competency Exam

assigned to them and took all of the posttests. (See the two right-hand columns in Table 1 for data related to them.)

Normative students

Additionally, five other groups of students served as normative comparison groups. They and their parents also signed consent forms to participate. Group 1 included 20 students regularly enrolled in 8th-grade inclusive general education English classes who wrote paragraphs; Group 2 included 16 students in other 8th-grade inclusive general education English classes who wrote themes. Group 3 included 20 students enrolled in a 9th-grade Advanced English (AP) class who wrote themes. Group 4 included 21 students regularly enrolled in a 12th-grade AP English class who wrote paragraphs. Group 5 included 21 students regularly enrolled in another 12th-grade AP English class who wrote themes. All of these normative students simply took part in their regularly assigned writing instruction during the full school year. They were paid $25 for their participation, which involved creating the assigned type of writing sample at the beginning and end of the school year. The students who were enrolled in regular general education courses represented a wide variety of academic skills and may have included students with IEPs who had been mainstreamed in the inclusive classes. The students enrolled in the AP classes were those who enrolled in those classes and were accepted by the school to participate in them. They also may have included students with IEPs, but the researchers were not given permission

to collect data related to IEP status or diagnoses. (See Table 2 for their demographic and test information.)

Setting

The setting for the participants in the study was a room outfitted with tables, chairs, and laptops on which the needed multimedia programs had been downloaded. A teacher desk was located in a corner of the room along with file cabinets and a printer, which all the students used for printing handouts and their completed written products. The settings for the normative students were their own regularly assigned classrooms. The school district in which all the students were regularly enrolled is located in a Midwestern suburb of a large metropolitan area. A total of 475 students were enrolled in the junior high, and 1500 students were enrolled in the senior high. Forty percent of the students enrolled in the junior high represented minority populations; 55% percent were receiving free or reduced-price lunches. The minority enrollment at the high school was 35%; 43% of the high-school students were receiving free or reduced-price lunches.

The interventions

The writing interventions

Four multimedia software programs were developed for teaching the following skills and strategies to the writing group: (a) fundamental skills and strategies associated with paragraph writing (Schumaker, 2013, 2020), (b) advanced paragraph-writing skills (Schumaker, 2014), (c) fundamental skills and strategies associated with theme writing (Schumaker, 2016), and (d) advanced theme-writing skills (Schumaker, 2015). The programs were designed to build upon each other. That is, students must learn how to write basic paragraphs before learning the advanced paragraph skills. Likewise, they must master writing paragraphs before learning how to write themes. Thus, students must master skills in one program before being allowed to begin another program.

The basic structure of the four software programs is parallel. Each program begins with an introduction which explains what skills the program teaches. The introduction is followed by several lessons, and most of the lessons have four segments: Learn It, Watch It, Study It, and Practice It. In the **Learn It** segment, the instruction proceeds through definitions and examples of concepts, along with explanations of cognitive strategies students can use as they write. Presentations on the screens include narration, text, animation, color coding, graphics, and visual art. Each screen contains a number of buttons which the learner can click to move forward, backward, pause the program, exit the program, increase or decrease the volume of the narrator's voice, repeat the instruction on the same screen, read notes and handouts, go back and review information, print out materials, and complete practice activities. Interspersed with the information presented in the Learn It section are mini-practice activities to which the student must respond. If the student's response is correct, the student may continue to the next screen in the program. If it is not correct, the student needs to answer the item again. Through this process, students learn information about how to write either sentences, paragraphs, or themes, depending on the individual software program.

In the **Watch It** segment of a lesson, students watch videoclips of a student actor applying the concepts and using the pertinent strategies that have been taught in the Learn It segment. In each videoclip, a student actor thinks aloud while using the strategies so that the learner can witness all the cognitive processes involved while writing. The actor's writing is shown on the screen. Interspersed throughout are questions to which the learner must respond to demonstrate understanding. Again, the student is allowed to move forward only after answering a question correctly.

In the **Study It** segment of a lesson, students engage in games and other activities so that they can memorize and recall the steps of the strategies and other conceptual information which they need to know in order to instruct themselves through the writing process. At the end of the Study It segment,

students take an oral or written quiz on which they must earn a score of 100% correct in order to move on to the next segment. They can take the quiz as many times as needed to reach this mastery criterion.

In the **Practice It** segment of a lesson, students practice using the skills and strategies. For example, in the complete sentences lesson, they initially practice identifying subjects and verbs. The activities are carefully scaffolded such that students master writing more and more difficult sentences in sequence. Later, in the advanced paragraph-writing program, at the end of the Persuasive Paragraph lesson, they practice planning and writing a whole persuasive paragraph. They can request to be prompted through the process by the computer, or they can choose to write the product independently. However, they must write their assigned paragraph independently and earn at least 85% of the points available before they can progress to the next lesson.

Students progress through each of the four programs in a linear fashion, following the narrator's instructions, attending to visual signals, and using buttons that are present on each screen. Although most of the activities are scored by the computer, at particular points, they must take their completed quiz or written product to the instructor, receive feedback from the instructor, and if the mastery criterion has been met, receive a pass code from the instructor to enter into a box on the screen to be allowed to go to the next lesson segment or the next lesson. Students can exit the program from any screen and receive a code that they can use to reenter that exact screen the next time they open the program.

Each of the four programs has a unique space odyssey plot woven through it. As the learner progresses through each program, a mystery or problem is introduced, clues are provided, and the problem is eventually solved. As much as possible, pictures, example sentences, paragraphs, themes, activities, and ideas presented on the screen adhere to the space theme and space plot throughout each program. (See, Figures 1–4 for example screen shots.)[3]

Figure 1. Example LEARN IT screen showing the structure of a paragraph. (Please note: This figure shows the final screen shot. The information comes on the screen as the narrator names it).

[3]Please note that these photos are static whereas the program is animated with narration.

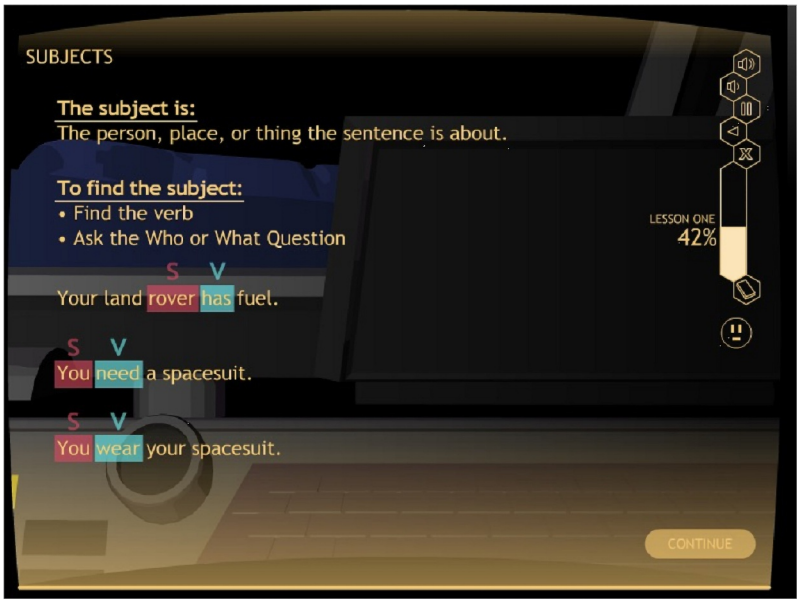

Figure 2. Example screen showing a mini-practice activity where students identify the verb and the subject in a simple sentence. (Please note: The information on the screen is fully narrated. The "S" and "V" appear when the student indicates their placement).

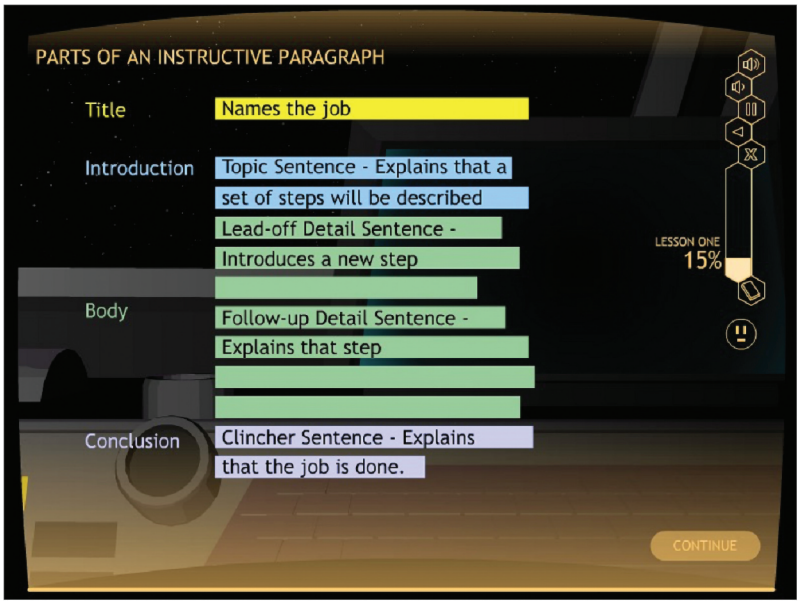

Figure 3. Example LEARN IT screen showing the structure of an Instructive Paragraph.

The content across the four software programs varies according to the type of writing being taught. For the *Fundamentals in Paragraph Writing* program (Schumaker, 2013, 2020), the five lessons focus on (1) writing complete sentences, (2) writing Topic Sentences, (3) planning paragraphs, (4) writing Detail Sentences, and (5) writing Clincher (concluding) Sentences. The complete sentences lesson (Lesson 1) is based loosely on the instruction of the Sentence Writing Strategy instructor's manuals

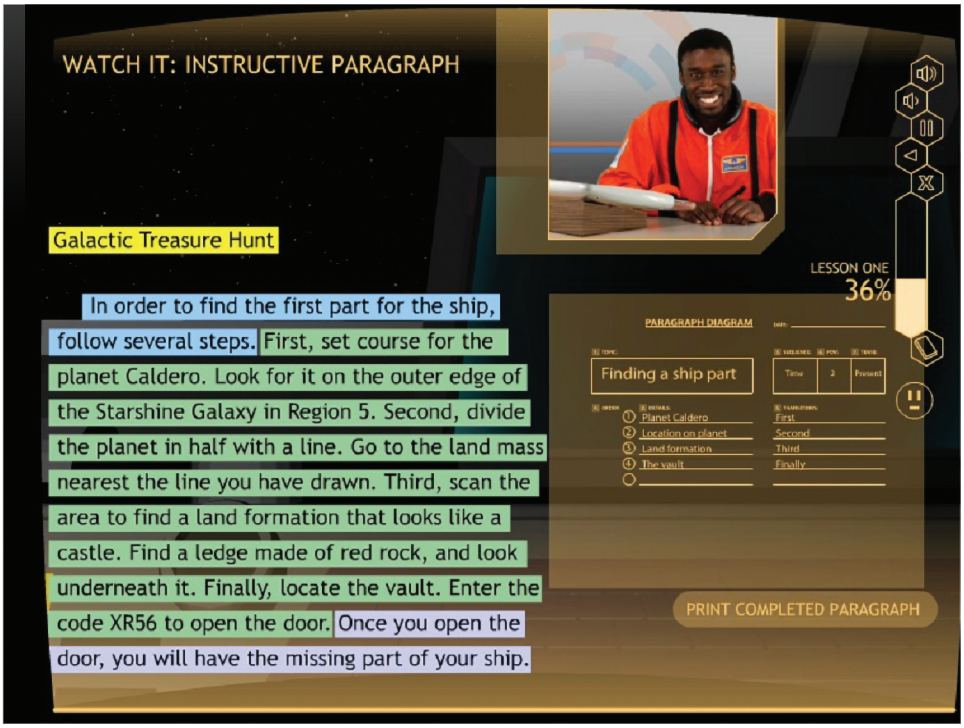

Figure 4. Example WATCH IT screen showing a student modeling how to plan and write a paragraph. (Please note: The paragraph appears on the screen as the student writes each word and states it).

(Schumaker & Sheldon, 1985, 1998). The paragraph-writing lessons are based onSchumaker and Lyerla's instructional program for the Paragraph Writing Strategy (Schumaker & Lyerla, 1991). By the end of the program, students are required to write a whole paragraph containing an organized structure and at least eight complete sentences. (See Schumaker (2020) for a detailed description of this software program and the results of a study devoted to this program.)

In the *Proficiency in Paragraph Writing* program (Schumaker, 2014), the second program in the series, the five lessons focus on (1) Instructive Paragraphs, (2) Narrative Paragraphs, (3) Persuasive Paragraphs, (4) Informative Paragraphs, and (5) Descriptive Paragraphs. At the end of each lesson, which contains Learn It, Watch It, and Practice It segments, students are required to plan and write a well-organized paragraph of the type taught, containing at least eight complete sentences.

In the *Fundamentals in Theme Writing* program (Schumaker, 2016), the third software program in the series, the three lessons cover (1) Introductory Paragraphs, (2) Detail Paragraphs, and (3) Concluding Paragraphs. At the end of each lesson, students are required to write the type of paragraph taught to a mastery criterion. To complete the program, students are required to plan and write a theme containing at least five well-organized paragraphs and complete sentences. This program is based on the instructor's manual for the Theme Writing Strategy (Schumaker, 2003).

In the *Proficiency in Theme Writing* program (Schumaker, 2015), the fourth software program in the series, the three lessons focus on (1) Informative Themes, (2) Persuasive Themes, and (3) Narrative Themes. To complete a given lesson, students are required to write an organized theme of the type covered in the lesson, containing well-organized paragraphs and complete sentences. This software program is based on the instructor's manuals for advanced instruction on the Theme Writing Strategy (Schumaker, 2012a, 2012b, 2018).

Designed to be compatible with Macintosh and Windows computers, the software programs were created using Flash MX 2004 Professional. Each program contains stand-alone software. By following the instructions of the narrator, completing activities, and clicking on the screen as buttons appear and become active, students progress intuitively through each program. The program allows students to go backwards through the program to review any screen they wish to experience again. They can progress forward only after listening to the whole narration on a screen or completing an activity correctly. They can progress to the next lesson only after reaching mastery on the current lesson and entering a passcode on the last screen of the lesson. Each program was thoroughly tested by project staff and student volunteers to identify errors and to determine that there was no way for a student to "break" the program or "cheat." Thus, there was no way for a student to jump through a lesson or skip any of the instruction.

The alternative academic interventions

The alternative academic interventions were multimedia software programs focused on the instruction of academic skills other than writing. They were the software programs used by the academic-skills group. All of these software programs had undergone previous field tests and were found to be effective in improving students' skills by researchers at our research organization. These alternative software programs included the following: (a) a program for teaching use of the Test-Taking Strategy (Hughes et al., 1988; Lancaster et al., 2006, 2007, 2009); (b) a program for teaching use of the LINCS Vocabulary Strategy (Ellis, 1992; Lancaster et al., in press b); (c) a program for teaching the meaning of prefixes, suffixes, and roots called *Word Smith* (Harris et al., 2008; Lancaster et al., in press c); (d) a program for teaching students to use the Word Mapping Strategy, called *Word Sleuth* (Harris et al., 2008, 2011; Lancaster et al., in press d); (e) a program for teaching use of the Self-Advocacy Strategy (Lancaster et al., 2002; P.E. Lancaster et al., 2005; Van Reusen et al., 2015); and (f) a program for teaching use of the Listening and Notetaking Strategy (Berry, 2011; Lancaster et al., in press a). The instructional procedures built into these software programs are similar to those used in the multimedia writing programs described above. However, the content and structure of these programs was different from the writing programs and each other, and no writing skills related to writing sentences, paragraphs, and themes were taught in any of these programs. Although students are required to do some writing as they work through the instruction in the Listening and Notetaking Strategy program, they simply had to write one word or one phrase on each line as they took notes while listening to a lecture. This group of programs was chosen because the total time required by most students to complete all the programs was projected to be similar to the time required to complete the four writing programs assigned to the writing group. Because students must reach mastery to complete each of the programs in the study and students take different amounts of time to reach mastery, there was no way to determine that the two groups of programs would require the same amounts of time across the groups. Time was "student specific" because of the mastery criteria that students had to meet in each program.

Measures

Fidelity of writing instruction

In order to verify that the students in the writing group completed the four multimedia programs, they raised their hand when they started and when they completed a program segment. The segment name, the start time, and the end time was recorded by a project staff member after verifying the part of the program by looking at the computer screen. The total amount of time spent on the writing lessons was determined for each student by summing the hours spent across all instructional sessions.

In order to verify that students were actually completing the work in each writing lesson, a quiz was used as a measure of each student's understanding and retention of the information that had been presented in the lesson. The quiz was comprised of open-ended questions that required the student to write a word or phrase. It was administered at the end of each Study It section. The student printed out

a copy of the quiz and completed it by hand (or orally). It was scored using an answer key. One point was awarded for each correct answer, and a percentage score was calculated for each quiz. A variable number of points was available for each quiz. Students were required to answer 100% of the questions on the quiz correctly to reach mastery. They could take the quiz as many times as needed to reach mastery.

Practice activity scores

The performance of students in the writing group on the writing practice activities was determined by scoring each written item as correctly matching the prompt and by calculating the percentage of items/sentences correctly written. These activities required students to plan or write sentences, paragraphs, or themes, depending on a student's place in the programs.

Sentence & paragraph knowledge test

This written fill-in-the-blank test focused on information related to sentence and paragraph writing. An example question asked the student to name the four steps of a strategy and was followed by four blanks to be filled in. Students could choose to take the test orally or in writing. A correct answer in a given blank earned one point; 46 points were available. Scorers used an answer key to score the test.[4]

Sentence & paragraph skills test

This written test presented the student with eight probes (e.g., "Write a complete compound sentence containing a semicolon," or "Write a complete Lead-off Detail Sentence for the topic "Rooms in a home" and the detail "kitchen."). Each sentence written by a student earned one point for completeness and one point for correctly matching the probe. A total of 8 points for sentence completeness and 8 points for matching the probe was available. To aid their scoring, scorers used a written protocol listing the probes and example correct sentences that could be written for each probe. The number of complete sentences and the points earned for matching the probes were the two raw scores derived from this instrument.[5]

Paragraph planning and writing tests

Two written genre tests (one for the persuasive and one for the narrative genre) each required the students to plan and write an organized paragraph containing at least eight sentences. Two parallel prompts (A & B) were designed for each paragraph genre. Students were given a blank piece of paper and a *Paragraph Diagram* (Schumaker & Lyerla, 1991, p. 358) plus lined paper before taking each test. They were asked to plan and write a well-organized paragraph in response to the prompt. An example prompt for a persuasive paragraph was "Write a persuasive paragraph about why junior-and senior-high school students should go to school during 12 months every year," and an example prompt for a narrative paragraph was "Tell a story about something funny that happened." To control for the difficulty of the prompts, the selection of the prompts was counterbalanced such that half of the students in each experimental group received one of the prompts (Prompt A) during the pretest and then received the other prompt (Prompt B) for the posttest. The other half of the students in each group received the prompts in opposite order (i.e., Prompt B during the pretest and Prompt A during the posttest).

The written paragraphs were scored using a score sheet listing the potential types of sentences in order, starting with the Topic Sentence and ending with the Clincher (i.e., concluding) Sentence. Each type of sentence could be awarded varying numbers of points depending on the quality of the sentence. For example, the Clincher Sentence could be awarded 8 points, 4 points, or 0 points. Scorers used a written set of evaluation guidelines to guide their awarding of points (see the Evaluation Guidelines

[4]For more details on this test, see Schumaker (2020).
[5]For more details on this test, see Schumaker (2020).

in Schumaker & Lyerla, 1991 on pages 247–262; Schumaker, 2020 for details). A total of 50 points was available for each paragraph.

Each student's written plan was scored regardless of whether the student made the plan on a blank sheet of paper or on a printed copy of a blank *Paragraph Diagram* (Schumaker & Lyerla, 1991). Various key pieces of information (e.g., the topic, three details, three transition words, a Topic Sentence) were awarded 1 point each for a total of 12 points. Scorers used a written protocol to determine whether or not to award a point for each item.

Theme knowledge test

This written fill-in-the-blank test was designed to test student knowledge of theme writing and parts of themes. Example items were "What types of sentences would you include in an Introductory Paragraph?," and "What are the jobs/purposes of a Topic/Transition Sentence?" followed by three blanks to be filled in. Each correctly filled-in blank was awarded one point. Scorers scored the tests using an answer key. A total of 44 points was available.

Theme skills test

The first part of this written test was comprised of six prompts; each prompt required the student to write a certain type of sentence pertinent to writing a theme. An example prompt was "Write a complete Thesis Statement for a theme on the topic 'Green types of Transportation' with these subtopics: biking, walking and skateboarding." Two variables were derived from students' responses to this part of the test: the number of complete sentences (out of six), and the number of sentences that matched the prompts (out of six). Scorers were guided by a written protocol listing examples of sentences that the students might write in response to each prompt. They also used the evaluation guidelines for sentences in themes and for Theme Diagrams as published by Schumaker (2003, pp. 155–168). For the second part of the test, students were asked to create a written plan for a theme on the topic "Types of movies." They were given a blank sheet of paper and a printed copy of a *TOWER Diagram* (Schumaker, 2003, p. 225) on which they could choose to create a plan. Scorers used an example Theme Diagram as a guide and awarded one point for each item in the student's plan and calculated the percentage of items that appeared in the student's plan (63 were possible).

Theme planning and writing test

These two written genre tests each prompted the students to write a theme containing at least five paragraphs. Two prompts (A & B) were designed for each genre tested: the persuasive theme and the narrative theme. Students were given a blank piece of paper and a *TOWER Diagram* (Schumaker, 2003, p. 225) plus lined paper before taking each test. They were asked to plan and write a well-organized theme in response to the prompt. An example prompt was "Some people think that boys and girls in your school should not have to dress themselves according to a dress code. For example, . . . (examples of a dress code were provided). In a 5-paragraph theme, present a reasoned argument that girls and boys in your school SHOULD NOT BE required to dress according to a dress code. Be sure to use a variety of sentence types and well-organized paragraphs. All of your sentences should be complete sentences." To control for the difficulty of the prompts, the selection of the prompts was counterbalanced such that half of the students in each group received one of the prompts (Prompt A) during the pretest and then received the other prompt (Prompt B) for the posttest. The other half of the students in each group received the prompts in opposite order (i.e., Prompt B during the pretest and Prompt A during the posttest).

The themes were scored using a score sheet displaying the potential types of paragraphs in order, starting with the Introductory Paragraph and ending with the Concluding Paragraph. Each type of sentence within each paragraph could be awarded varying numbers of points depending on the quality of the sentence. For example, a Topic/Transition sentence between Detail Paragraphs could be awarded 4, 2, or 0 points, depending on the quality of the sentence. Scorers used a written set of evaluation guidelines to guide their selection of points (see the Evaluation Guidelines in Schumaker,

2003 on pp. 155–167). A total of 119 points was available on the theme. The *TOWER Diagram* was similarly scored using a set of Evaluation Guidelines (Schumaker, 2003, pp. 167–168). A total of 63 points was available.

Satisfaction questionnaires

Two questionnaires were created to determine the social validity of the computerized programs (Wolf, 1978). The **Satisfaction with Writing Questionnaire** was comprised of 15 seven-point Likert-type items through which students indicated their agreement with statements about their own writing (e.g., "I know how to write a 5-paragraph theme"). This questionnaire was administered at the beginning and end of the study to the Completers in the writing group and the academic skills group. The **Satisfaction with Programs Questionnaire** was comprised of 20 seven-point Likert-type items through which students indicated their satisfaction. Most of the items (14) related to satisfaction with the programs (e.g., "With the ease of navigation," "With the way the screens look," "With the narrator's voice"). Six items related to their satisfaction with whether the program taught them how to write (e.g., "Helped you learn to write different types of paragraphs," " . . . to write theme Introductory Paragraphs," " . . . to write theme Concluding Paragraphs"). This questionnaire was administered at the end of the study to the Completers in the writing and academic skills groups. The median rating was calculated for each item on each questionnaire for each group.

Interscorer reliability

To determine the reliability of the scorers, the students' names were obliterated from their products, and ID numbers were used. Further, the primary scorer and the reliability scorer were blind to the students' assignment to the groups. The scorers were trained by having them score a series of tests until they each reached an agreement percentage of 85% or higher for each test. Then twenty percent of the products of each type of test were randomly selected and scored by the two independent scorers. Their scores were compared item-by-item. An agreement was defined as an instance where both scorers gave the exact same score (e.g., 0, 1, 2, or 4) to the same sentence or item. The percentage of interscorer agreement was determined by dividing the number of exact agreements on individual items by the total number of items scored.

The percentages of agreement were as follows: for the points earned on the Sentence and Paragraph Knowledge Test, 96.7% (871 agreements out of 900 possible); on the Sentence and Paragraph Skills Test for complete sentences, 96.3% agreement (154 agreements out of 160 possible) and on the points earned for matching the prompt, 95% agreement (152 agreements out of 160 possible); on the Persuasive Paragraph Test for complete sentences, 96.5% agreement (275 out of 295 possible), on the points earned for organization, 92% agreement (397 agreements out of 432 possible, and for the points earned on the Persuasive Paragraph Diagram, 99.8% (506 agreements out of 507 possible); on the Narrative Paragraph Test for complete sentences, 93.6% (265 out of 283 possible), for points earned for organization, 85.9% (438 agreements out of 510 possible), and for points earned on the Narrative Paragraph Diagram, 99.4% (164 agreements out of 165 possible). The percentages of agreement for the theme-writing scores were as follows: for the points earned on the Theme Knowledge Test, 91.5% (1242 agreements out of 1364 possible); on the Theme Skills Test for the complete sentences, 95% (114 agreements out of 120 possible), for the points earned for matching the prompts, 87.5% (105 agreements out of 120 possible), and for the Theme Planning Diagram, 97.9% (1194 agreements out of 1220 possible); on the Persuasive Theme Test for organization points earned, 88% (935 agreements out of 1060 possible) and for planning, 96% (968 agreements out of 1011 possible); on the Narrative Theme Test for organization points earned, 89.3% (802 agreements out of 898 possible) and for planning 98.2% (550 agreements out of 560 possible).

Procedures

All of the students (the **writing group, academic-skills group**, and normative students) participated in their regularly scheduled education programs at their schools throughout the study. Students assigned to the **writing group** worked through the four writing software programs described above. Students selected for the **academic-skills group** were assigned to use the six alternative software programs. The staff member introduced each student to the first program assigned to that student and showed the student how to open the program and navigate to the first screen. Thereafter, students worked through the programs individually and intuitively at their own pace, alerting the project staff member as to when they were starting and finishing a program component. Students printed out their completed practice samples (e.g., sentences, paragraphs, themes for the writing group; other practice activities for the academic-skills group) to submit to the project staff member to score and provide feedback.

All students in the writing group and the academic-skills group were administered all the tests and the Satisfaction with Writing Questionnaire before they began the instruction. When students in the writing group completed the two software programs for writing paragraphs (Schumaker, 2013, 2014) and students in the academic-skills group completed the software programs for the Test-Taking Strategy (Lancaster et al., 2007), the Vocabulary Strategy (Lancaster et al., in press a), and *Word Smith* (Lancaster et al., in press b), they were again administered the Sentence & Paragraph Knowledge Test, the Sentence & Paragraph Skills Test, and the Paragraph Planning and Writing Tests.

When the writing completers completed the two multimedia software programs on writing themes, and the academic-skills completers completed the software programs for the Self-Advocacy Strategy (P.E. Lancaster et al., 2005), *Word Sleuth* (Lancaster et al., in press c), and the Listening and Notetaking Strategy (Lancaster et al., in press d), they were administered the Theme Knowledge Test, the Theme Skills Test, and the Theme Planning and Writing Tests. No time limits were imposed during any test in the study. All of the completers in both groups were also administered the two satisfaction questionnaires at the end of the study.

Students in the normative groups were administered tests at the beginning and end of the school year. Students in Groups 1 and 3 were administered the Planning and Writing Paragraph Tests for persuasive and narrative paragraph writing. Students in Groups 2, 4 and 5 were administered the Planning and Writing Theme Test for persuasive theme writing.

Experimental design and data analysis

Analyses on the equivalence of the groups

To determine the equivalence of the **writing group and the academic-skills group**, One-way ANOVAS were conducted with the gender, school-level (jr/sr high), grade, ethnicity, and special-education status data. Independent Samples t-tests were applied to the standardized test-score data in separate analyses. In all of these analyses, $p = .0055$ was used as the probability value for statistical significance. The same analyses were conducted to determine the equivalence of the completer groups and then separately for the completer and half-completer groups.[6] Next, to determine the equivalence of the completers' and half-completers' beginning skills, each of their pretest scores on nine outcome variables related to sentence and paragraph writing were compared using Independent Samples t-tests, with $p = .0055$ as the probability value, to control for Type 1 error. Finally, to determine the equivalence of the experimental and normative groups, One-way ANOVAS were conducted with the demographic variables, and Independent Samples t-tests were applied to the standardized test score data.

[6]Because standardized test scores were not available for some of the students who did not complete the study, analyses related to those scores were not able to be conducted.

Design and analyses for the outcome variables

A pretest-posttest control-group design was employed (Campbell & Stanley, 1963). Separate univariate ANOVAs were used to compare the pretest to posttest scores for the writing group and also for the academic-skills group for each variable. ANCOVAs with a fixed effect for experimental condition were used to compare the writing students' posttest raw scores to the academic-skills students' posttest raw scores on each variable while using their pretest raw scores as covariates. Analyses were conducted for all the writing students and academic-skills students on the sentence and paragraph measures. Only the completers subgroups were included in the analyses for the theme-writing measures. Follow-up tests were conducted separately for the writing group to determine whether girls' posttest scores were significantly different from boys' posttest scores and whether junior-high students' posttest scores were significantly different from senior-high students' posttest scores. Only those students who took the pretest and the posttest related to a given outcome variable were included in the analysis for that variable.

Analyses on the satisfaction ratings

With regard to the statistical analyses for the Satisfaction with Writing Questionnaire, Paired Samples *t* tests were used to compare the pretest ratings to the posttest ratings for the writing and academic-skills groups separately. Then, a two-way ANOVA was used to compare the effects of time (pretest versus posttest), condition, and the interaction of those two factors on the satisfaction ratings. For the Satisfaction with Programs Questionnaire, first, the ratings for the items related to the computer program itself were compared across the completer groups using a one-way ANOVA. Likewise, the ratings for the writing items were compared across the completer groups in a separate one-way ANOVA.

Analyses on the normative comparisons

With regard to the statistical analyses involving the normative groups of students, separate univariate ANCOVAs were used to compare the posttest scores for the whole writing group to the posttest scores for the selected groups of normative students (Groups 1 and 3 on paragraph measures; Groups 2, 4, & 5 on theme measures) and to compare the posttest scores for the groups of junior-high students and senior-high students separately within the larger groups, with a fixed effect for group and the pretest score serving as the covariate. These analyses with the normative students were conducted on the students' scores for points earned for paragraph organization, number of complete sentences in the paragraph, and planning scores for both persuasive and narrative paragraphs, as well as points earned for planning and writing persuasive themes.

Results

Group equivalence results

The analyses showed that there were no differences between the whole writing group and the whole academic-skills group with regard to gender ($F(1, 67) = .215$, $p = .645$), school level ($F(1, 67) = .054$, $p = .817$), grade ($F(5, 62) = 1.995$, $p = .092$), ethnicity ($F(3, 60) = .514$, $p = .674$), and special education designation ($F(1, 63) = 1.118$, $p = .294$). Also, there were no differences on the state math competency test ($t(26.15) = 1.825$, $p = .079$) and the state reading competency test ($t(23.27) = 1.519$, $p = .142$). Likewise, there were no differences between the completers in the writing and academic-skills groups on any of these variables.[7] There were also no differences between the completers and half-completers with regard to any of the demographic variables, test scores, and pretest scores.[8] Thus, the students who did not complete all the designated software programs were not different from those who did.

[7]Statistics related to these analyses are available from the author.
[8]Statistics related to these analyses are available from the author.

Table 3. Mean percentage scores and mean number of attempts on the quizzes for each lesson by students in the writing group.

Lesson	Percentage Score	Number of Attempts
Fundamentals in Paragraphs		
1	91.64	1.5
2	94.78	1.1
3	97.08	1.2
4	94.93	1.1
5	96.35	1.3
Fundamentals in Themes		
1	87.16	1.2
2	99.68	1.2
3	96.42	1.2
Proficiency in Themes		
1	96.06	1.2
2	92.72	1.3
3	97.86	1.1

Similarly, when the normative groups were compared to the writing group and academic-skills group and to each other, no differences were found related to any of the demographic variables. When analyses were conducted comparing the test scores across the groups, the normative students in Group 2 (8th graders) earned significantly lower state math scores than the other groups. No other significant differences were observed.[9]

Instructional fidelity results

The results recorded by the staff member who observed the students as they worked through the software programs indicated that all the students completed 100% of the parts of all the software programs that were assigned to them. The total amount of instructional time spent by the completers in the writing group when completing the four writing programs ranged from 28.5 to 103 hours (M = 68 hours). The results for the Knowledge Quizzes for all the writing students are shown in Table 3, including the mean score for each quiz and the mean number of times students took the quiz in order to reach the mastery criterion of 100% correct. Most of the students met mastery on their first attempt on each quiz after they experienced the tough requirement for mastery on the first quiz.

Practice activity results

Table 4 shows the results of the writing practice activities where writing group students submitted written products to the instructor. These results indicate that most students met mastery on the first trial attempt on all the activities. The activity that required the most number of attempts was the first lesson on completing four types of simple sentences (M= 1.48 attempts).

Sentence & paragraph test results

The results for the sentence and paragraph tests for the writing and academic-skills groups are displayed in Table 5. Shown are the mean raw scores and standard deviations for the pretests and posttests (in the two left-hand columns) plus the statistical analysis results for the within-groups and between-groups comparisons (in several right-hand columns). The ANOVAs comparing pretest to posttest scores for each group showed that the writing group's posttest scores were significantly higher than their pretest scores on all variables, while the academic-skills group's posttest scores were significantly higher on only one variable (i.e., the Knowledge Test). The academic-skills group gained

[9]Statistics related to these analyses are available from the author.

Table 4. Mean percentage scores and mean number of practice sets attempted on the practice levels during each lesson by students in the writing group.

Lesson	Practice Level	Percentage Score	Number of Practice Sets
Fund. in Paragraphs			
1	1	85.58	1.48
	2	92.00	1.28
	3	90.27	1.28
	4	98.71	1.17
2	1	88.50	1.27
	2	93.71	1.21
3	1	97.00	1.07
4	1	98.18	1.10
	2	94.44	1.20
	3	99.30	1.00
	4	96.25	1.00
5	1	91.35	1.28
	2	87.36	1.27
	3a*	100.00	1.00
	3b	99.58	1.00
Prof. in Paragraphs			
1	1a	99.08	1.00
	1b	93.75	1.00
2	2a	100.00	1.00
	2b	99.17	1.00
3	3a	99.31	1.00
	3b	98.79	1.00
4	4a	99.08	1.00
	4b	97.58	1.00
5	5a	100.00	1.00
	5b	99.60	1.00
Fund. in Themes**			
1	1	97.00	1.08
2	2	98.60	1.07
3	3	93.10	1.16
Prof. in Themes**			
1	1a	100.00	1.00
	1b	97.50	1.00
2	2a	92.30	1.00
	2b	100.00	1.00
3	3a	88.80	1.00
	3b	100.00	1.00

* "a" denotes planning practice, and "b" denotes writing practice in relation to the same prompt.
** These data were gathered from Completers only.

an average of 3.8 points, while the writing group students gained an average of 35 points on that variable. All of the effect sizes were large.

The ANCOVAs comparing the writing group's posttest scores to the academic-skills students' posttest scores while controlling for the pretest scores revealed a significant difference at the .001 level for all variables associated with all the tests as indicated by the asterisks. In all cases, the writing group's posttest scores were significantly higher than the academic-skills group's posttest scores. For six of the nine variables, the effect size was very large as indicated by the [c]. For three of the variables, which were all related to Complete Sentences scores, the effect sizes were small to moderate. This result is probably due to the small number of sentences in a paragraph. When the results for the boys versus girls and for junior-high versus senior-high students in the writing group were compared, no differences were found for any variable.

Table 5. Mean raw scores, standard deviations, and statistical comparisons on the sentence and paragraph writing measures.

			Means		Within-Group Effects			Between-Group Effects		
Test	Measure	Group	Pre (SD)	Post (SD)	Statistic	*p* -value	Effect size	Statistic	*p* -value	Effect size
Sentence & Paragraph Knowledge Test	Total Score (out of 46)	Writing	8.38 (5.00)	43.62 (3.12)	$F(1, 31) = 975.18$	$p < .001$**	$\eta^2 = .969^c$	$F(1, 68) = 649.751$	$p = .001$**	$\eta^2 = .908^c$
		Academic	11.68 (6.88)	15.41 (6.69)	$F(1, 36) = 19.77$	$p < .001$**	$\eta^2 = .354^c$			
Sentence & Paragraph Skills Test	Complete Sentences (out of 8)	Writing	3.69 (2.26)	6.84 (1.76)	$F(1, 31) = 53.07$	$p < .001$**	$\eta^2 = .631^c$	$F(1, 68) = 32.645$	$p = .001$**	$\eta^2 = .331^c$
		Academic	5.00 (2.35)	4.62 (2.28)	$F(1, 36) = 1.00$	$p = .324$				
	Prompts Matched (out of 8)	Writing	2.38 (1.77)	6.91 (1.06)	$F(1, 31) = 328.52$	$p < .001$**	$\eta^2 = .857^c$	$F(1, 68) = 203.541$	$p = .001$**	$\eta^2 = .755^c$
		Academic	3.11 (2.03)	2.65 (1.86)	$F(1, 36) = 3.463$	$p = .071$				
Persuasive Paragraph Test	Pers Parag Org Score (out of 50)	Writing	21.56 (8.84)	39.13 (4.76)	$F(1, 31) = 118.14$	$p < .001$**	$\eta^2 = .792^c$	$F(1, 68) = 76.239$	$p = .001$**	$\eta^2 = .536^c$
		Academic	22.81 (7.58)	25.14 (8.21)	$F(1, 36) = 2.11$	$p = .155$				
	Complete Sentences (out of 8)	Writing	6.28 (2.25)	7.59 (.065)	$F(1, 31) = 11.48$	$p < .002$**	$\eta^2 = .270^c$	$F(1, 68) = 5.829$	$p = .019$*	$\eta^2 = .081^b$
		Academic	7.00 (0.94)	6.97 (1.46)	$F(1, 36) = 0.01$	$p = .919$				
	Pers Planning Score (out of 12)	Writing	.66 (1.89)	11.38 (2.12)	$F(1, 31) = 503.26$	$p < .001$**	$\eta^2 = .942^c$	$F(1, 68) = 412.122$	$p = .001$**	$\eta^2 = .862^c$
		Academic	.73 (1.84)	.95 (2.26)	$F(1, 36) = 0.34$	$p = .563$				
Narrative Paragraph Test	Narrative Paragraph Org. Score (out of 50)	Writing	23.19 (7.29)	36.81 (6.44)	$F(1, 31) = 75.86$	$p < .001$**	$\eta^2 = .710^c$	$F(1, 68) = 49.751$	$p = .001$**	$\eta^2 = .430^c$
		Academic	25.41 (9.64)	25.73 (7.73)	$F(1, 36) = 0.04$	$p = .837$				
	Complete Sentences (out of 8)	Writing	6.16 (1.80)	7.41 (0.98)	$F(1, 31) = 13.839$	$p = .001$**	$\eta^2 = .309^c$	$F(1, 68) = 5.784$	$p = .037$*	$\eta^2 = .081^b$
		Academic	6.76 (1.50)	6.78 (1.62)	$F(1, 36) = 0.01$	$p = .923$				
	Narrative Planning Score (out of 12)	Writing	.62 (1.91)	11.13 (2.94)	$F(1, 31) = 308.95$	$p < .001$**	$\eta^2 = .909^c$	$F(1, 68) = 436.994$	$p = .001$**	$\eta^2 = .869^c$
		Academic	.35 (1.21)	.24 (1.04)	$F(1, 36) = 0.24$	$p = .629$				

PPCG = Pretest-Posttest Control-Group Design; Writing = Writing Group; Academic = Academic-Skills Group. [a] reflects a small effect size; [b] reflects a medium effect size; [c] reflects a large effect size; * indicates a statistically significant p-value at the .05 level; ** indicates a statistically significant p-value at the .001 level.

Table 6. Mean raw scores, standard deviations, and statistical comparisons for the theme writing measures.

		Means			Within-Group Effects			Between-Group Effects		
Test Name	Measure	Group	Pre (SD)	Post (SD)	Statistic	*p* -value	Effect size	Statistic	*p* - value	Effect size
Theme Knowledge Test	Total Score (out of 44)	Writing	8.63 (6.39)	38.70 (2.89)	$F(1, 26) = 596.82$	$p < .001$*	$\eta^2 = .958^c$	$F(1, 58) = 543.188$	$p = .001$*	$\eta^2 = .907^c$
		Academic	10.88 (6.32)	11.87 (6.5)	$F(1, 31) = 1.16$	$p = .291$				
Theme Skills Test	Complete Sentences (out of 6)	Writing	2.89 (1.93)	5.07 (1.33)	$F(1, 26) = 24.63$	$p < .001$*	$\eta^2 = .487^c$	$F(1, 58) = 15.788$	$p = .001$*	$\eta^2 = .220^c$
		Academic	3.22 (1.95)	3.56 (1.80)	$F(1, 31) = 1.04$	$p = .317$				
	Prompts Matched (out of 6)	Writing	1.48 (1.31)	4.93 (1.04)	$F(1, 26) = 132.90$	$p < .001$*	$\eta^2 = .836^c$	$F(1, 58) = 59.227$	$p = .001$*	$\eta^2 = .516^c$
		Academic	2.06 (1.41)	2.63 (1.66)	$F(1, 31) = 5.82$	$p = .022$				
	Theme Planning Score (out of 63)	Writing	12.56 (11.9)	49.19 (5.61)	$F(1, 26) = 237.71$	$p < .001$*	$\eta^2 = .901^c$	$F(1, 58) = 184.337$	$p = .001$*	$\eta^2 = .767^c$
		Academic	17.19 (11.5)	17.56 (11.09)	$F(1, 31) = 0.023$	$p = .882$				
Persuasive Theme Test	Pers Theme Organization Score (out of 119)	Writing	27.81 (19.6)	89.33 (23.86)	$F(1, 26) = 152.54$	$p < .001$*	$\eta^2 = .854^c$	$F(1, 58) = 132.447$	$p = .001$*	$\eta^2 = .703^c$
		Academic	35.09 (18.9)	39.00 (16.70)	$F(1, 31) = 3.19$	$p = .084$				
	Pers Theme Planning Score (out of 63)	Writing	1.48 (3.81)	44.85 (2.74)	$F(1, 26) = 2693.18$	$p < .001$*	$\eta^2 = .990^c$	$F(1, 58) = 1232.362$	$p = .001$*	$\eta^2 = .957^c$
		Academic	4.66 (9.13)	3.16 (6.74)	$F(1, 31) = 1.24$	$p = .274$				
Narrative Theme Test	Narrative Theme Organization Score (out of 119)	Writing	40.56 (19.4)	95.97 (2.75)	$F(1, 26) = 218.49$	$p < .001$*	$\eta^2 = .894^c$	$F(1, 58) = 148.309$	$p = .001$*	$\eta^2 = .726^c$
		Academic	54.78 (17.7)	50.33 (2.51)	$F(1, 31) = 0.97$	$p = .333$				
	Narr Theme Planning Score (out of 63)	Writing	1.70 (4.30)	44.96 (7.01)	$F(1, 26) = 919.19$	$p < .001$*	$\eta^2 = .972^c$	$F(1, 58) = 132.447$	$p = .001$*	$\eta^2 = .703^c$
		Academic	4.38 (8.01)	1.50 (5.91)	$F(1, 31) = 2.93$	$p = .097$				

Note. Pretest-Posttest Control-Group Design: Pre = Pretest; Post = Posttest; Writing = Writing Group; Academic = Academic Skills Group

[a]reflects small effect size, [b] reflects medium effect size, [c] reflects large effect size, and * indicates statistically significant p-value at the .001 level.

Theme test results

Similar types of data and statistical results for all the theme-writing measures are displayed in Table 6 for the completers. With regard to the within-group differences, a significant difference between the pretest and posttest results was found for every variable for the writing completers in favor of the posttest, representing large effect sizes. No within-group differences were apparent for the academic-skills completers. With regard to the between-group differences, a significant difference was found between the posttest scores of the completers in the writing and academic-skills groups in favor of the writing group when the pretest scores were controlled. In the case of all variables, a large effect size was realized.

Results for the school-level comparisons

Univariate ANOVAs with a fixed effect for level of schooling were used to compare junior-high **writing** students' pretest raw scores to the senior-high **writing** students' pretest raw scores on each

Table 7. Mean raw scores, standard deviations, and statistical data for the normative comparisons.

			Means		Within-Group Effects			Between-Group Effects		
Test Name	Measure	Group	Pre (SD)	Post (SD)	Statistic	*p* -value	Effect size	Statistic	*p* -value	Effect size
Persuasive Paragraph Test	Paragraph Organization Score (out of 50)	Writing	21.56 (8.84)	39.13 (4.76)	$F(1, 31) = 118.14$	$p < .001$*	$\eta^2 = .792^c$	$F(1, 72) = 168.10$	$p < .001$*	$\eta^2 = .706^c$
		Norm	22.24 (8.75)	21.02 (8.00)	$F(1, 40) = 1.16$	$p = .289$				
	Complete Sentences (out of 8)	Writing	6.28 (2.25)	7.59 (.665)	$F(1, 31) = 11.48$	$p < .001$*	$\eta^2 = .270^c$	$F(1, 72) = 20.907$	$p < .001$*	$\eta^2 = .230^b$
		Norm	6.20 (2.05)	6.44 (1.38)	$F(1, 40) = 0.689$	$p = .411$				
	Persuasive Planning Score (out of 12)	Writing	.66 (1.89)	11.38 (2.12)	$F(1, 31) = 503.26$	$p < .001$*	$\eta^2 = .942^c$	$F(1, 72) = 1101.048$	$p < .001$*	$\eta^2 = .940^c$
		Norm	.05 (.312)	.00 (.000)	$F(1, 40) = 1.00$	$p = .323$				
Narrative Paragraph Test	Paragraph Organization Score (out of 50)	Writing	23.19 (7.29)	36.81 (6.44)	$F(1, 31) = 75.86$	$p < .001$*	$\eta^2 = .710^c$	$F(1, 72) = 53.361$	$p = .001$*	$\eta^2 = .433^c$
		Norm	25.93 (6.97)	25.80 (6.87)	$F(1, 40) = 0.01$	$p = .928$				
	Complete Sentences (out of 8)	Writing	6.16 (1.80)	7.41 (.979)	$F(1, 31) = 13.839$	$p < .001$*	$\eta^2 = .309^c$	$F(1, 72) = 19.884$	$p = .001$*	$\eta^2 = .221^b$
		Norm	6.00 (2.05)	6.02 (1.67)	$F(1, 40) = 0.01$	$p = .929$				
	Narrative Planning Score (out of 12)	Writing	.62 (1.91)	11.13 (2.94)	$F(1, 31) = 308.95$	$p < .001$*	$\eta^2 = .909^c$	$F(1, 72) = 148.309$	$p = .001$*	$\eta^2 = .726^c$
		Norm	.00 (.000)	.00 (.000)	*Not calculated (no students made plans)*					
Persuasive Theme Test	Organization Score (out of 119)	Writing	27.81 (19.6)	89.33 (23.86)	$F(1, 26) = 152.54$	$p < .001$*	$\eta^2 = .854^c$	$F(1, 80) = 80.218$	$p = .001$*	$\eta^2 = .667^c$
		Norm	42.89 (17.6)	41.39 (18.69)	$F(1, 54) = .607$	$p = .439$				
	Theme Planning Score (out of 63)	Writing	1.48 (3.81)	44.85 (2.74)	$F(1, 26) = 2693.176$	$p < .001$*	$\eta^2 = .990^c$	*F(1, 79) = 1014.352*	*p < .001**	$\eta^2 = .963^c$
		Norm	3.50 (6.91)	4.35 (5.35)	*F(1, 54) = 6.769*	$p = .012$*	$\eta^2 = .111^b$			

Note. Pretest-Posttest Control-Group Design: Writing = Writing Group; Norm = Normative Group
[a]reflects a small effect size, [b] reflects a moderate effect size, [c] reflects a large effect size, and * indicates a statistically significant p-value.

Table 8. Mean raw scores and standard deviations on the persuasive theme measures for the experimental participants and the normative subgroups.

	Theme Organization (116 points)		Theme Planning (63 points)	
Group	Pretest (SD)	Posttest (SD)	Pretest (SD)	Posttest (SD)
Writing Group	27.81 (19.61)	89.33 (23.86)	1.48 (3.81)	44.85 (2.74)
Academic Skills Group	35.09 (18.85)	39.00 (16.70)	4.66 (9.13)	3.16 (6.74)
8th-Grade Normative Group	30.65 (17.23)	31.88 (17.95)	7.12 (9.40)	1.12 (2.34)
9th-Grade Normative Group	47.22 (17.13)	45.39 (18.35)	3.50 (6.91)	4.35 (5.35)
12th-Grade Normative Group	49.10 (13.46)	45.67 (17.49)	6.95 (5.55)	3.62 (4.47)

variable. Of interest was the question of whether senior-high students' pretest scores would be higher than junior-high students' scores since they presumably would have received more writing instruction in school. The results showed that there were significant differences between the senior-high and junior-high students' pretest scores on five of the variables, with the senior-high students scoring significantly higher than the junior-high students on all five variables: the score on the Sentence & Paragraph Knowledge Test, the complete sentences score on the Sentence & Paragraph Writing Skills Test, the prompt-matching score on the Sentence and Paragraph Skills Test, the score on the Theme Writing Knowledge Test, and the complete sentences score on the Theme Writing Skills Test.

The effect size (eta squared) for four of these measures was small (ranging from .075 to .086); the effect size for scores on the Theme Knowledge Test was large (.205). Notably, the actual magnitude of difference between the junior and senior-high scores was relatively small. For example, on the Sentence & Paragraph Knowledge Test, the average difference was 3.5 points (between a mean of 8.5 points to 12 points) on a test containing 46 points. Similarly, on the Theme Writing Knowledge Test, the average difference was 6 points (between a mean of 7 points to 13 points) on a test containing 45 points. Likewise, the differences on the three measures where students were prompted to write complete sentences were small (e.g., between 2 points and 3 points on both tests). In other words, neither the junior- or senior-high groups of students scored well on any of these pretests. The senior-high students' pretest scores were higher than the junior-high students' pretest scores, but they were not close to a mastery level or even a passing level (i.e., 60% of the points available) and not close to the scores earned by the **writing s**tudents on the posttests.

Results for the normative comparisons

The pretest and posttest results for the **writing group** and the normative groups are shown in Table 7 for the paragraph and persuasive theme measures. In relation to the within-group comparisons, significant differences were found on all the variables for the **writing group**, representing large effect sizes in each case. Only one significant within-group difference was found for the normative group; on the Theme Planning Score, they made an average gain of .8 points (in comparison to the average gain of 43.45 points for the **writing completers**). In relation to the between-group comparisons, there were significant differences between the posttest scores of the **writing students** and the normative students, with the **writing students** scoring significantly higher on the posttests than the normative group on all variables. The **writing group scored significantly higher than the normative students; the junior-high writing students** earned significantly higher scores than the junior-high normative group; and the senior-high **writing students** earned significantly higher scores than the senior-high normative group. The magnitude of the difference was similar in each case, not only representing large effect sizes, but also corresponding to very large gains on the part of the **writing students**.

Table 8 presents a more detailed picture of the results on the two persuasive theme measures for the writing completers, the academic-skills completers, and the 8th-grade, 9th-grade, and 12th-grade normative students who took the theme test. During the pretest on both measures, the 9th- and 12th-grade normative students' scores were somewhat higher than the other groups' scores. However, on the posttest, the writing completers' scores were significantly and substantially higher than all the other groups' scores, representing large effect sizes.

Satisfaction results

With regard to the students' satisfaction with their own writing, there was no difference found between the writing and academic-skills completers' ratings at pretesting ($F(1, 66) = .904$, $p = .345$, Cohen's $d = .249$). At posttesting, a significant difference was found, with writing completers' ratings ($M = 6.4$) exceeding the academic-skills completers' ratings ($M = 5.1$) ($F(1, 57) = 21.443$, $p < .001$, Cohen's $d = 1.210$). Moreover, there was a significant change from pretest to posttest ratings for the writing completers ($t(26) = 4.597$, $p < .001$, Cohen's $d = .885$), but not for the academic-skills completers ($t(1, 31) = 0.000$, $p = 1.00$, Cohen's d = 0). With regard to the students' ratings of software program elements, there was no difference between the groups ($F(1, 57) = 2.431$, $p = .125$, Cohen's $d = .412$). Both groups were satisfied (median rating of 5.9 for the writing completers and 5.6 for academic-skills completers) with the programs they used. Regarding their ratings of whether the programs helped them *learn to write*, the writing completers' ratings ($M = 5.9$) were significantly higher than the academic-skills completers' ratings ($M = 4.8$) ($F(1, 56) = 14.928$, p < .001, Cohen's $d = 1.020$), representing a large effect size.

Discussion

Conclusions

This article reports a study of four interactive multimedia programs for teaching writing skills to struggling adolescent writers. The results show that students who master the skills taught in the writing programs (i.e., the writing group) earned significantly higher posttest scores than their pretest scores on all measures of sentence, paragraph, and theme writing, with effect sizes ranging from medium (complete sentence scores) to large (other scores). Students who used the alternate computerized programs (the academic-skills group) earned significantly higher scores on the posttest than the pretest on only one measure (the Sentence & Paragraph Knowledge Test), and the magnitude of gain for them was only four points versus 35 points for the writing group. Further, the between-group comparisons showed that the writing students earned significantly higher posttest scores than the academic-skills students on all measures, with all comparisons representing large effect sizes. Students in the writing group were significantly more satisfied with their writing than students in the academic skills group at the end of the study. Finally, when the writing students' posttest scores were compared to the scores of a normative group of peers, a significant difference was found in favor of the writing group on all the compared measures. Thus, although the original goal was to show that the writing students were equivalent to the normative students on the posttests, the results showed that the writing group was statistically and substantially superior. When the posttest scores were compared to the pretest scores, the writing group earned posttest scores that were significantly higher than their pretest scores. The normative group earned only one posttest score significantly higher than the pretest score, and that gain represented only 1 point. Thus, the normative groups and the academic-skills group did not make substantial gains in writing skills during the study, while the writing group did.

With regard to the question of the effects of computer usage on writing growth, this study does not support the hypothesis that computer usage promotes growth in writing scores or even produce an advantage in writing performance. Although the students in the academic-skills group used computers throughout six instructional programs, they did not make gains in their writing skills. Since all the

students used paper and pencils during the pretests and posttests, and all the writing and academic-skills students used computers for a full year, this factor was controlled throughout the study.

Replications and extensions

These results relate to previous research in several ways. First, the sentence-writing and paragraph writing data are similar to the results of previous studies that used the same measures. For example, when students wrote a pretest paragraph in the current study, about 75% of the experimental students' sentences were complete, and they earned about 40% of the points available for paragraph organization. In the Schmidt et al. study (Schmidt et al., 1988/89), a mean of 70% of the students' sentences were complete, and they earned a mean of 56% of the points for paragraph organization. In the Schumaker (2020) study, a mean of 44% of the students' sentences were complete, and the students earned about 32% of the points on paragraph organization. In other words, the students in none of these samples, including the current one, had learned the basic skills associated with writing complete sentences and organized paragraphs anywhere close to mastery levels (above 90% for sentence completeness and 80% for paragraph organization).

Second, once the **writing group** worked through the multimedia program for sentence and paragraph writing in this study and in the Schumaker (2020) study, they made significant gains. Students wrote 94% and 95% complete sentences in the Schumaker (2020) study and in the current study, respectively, on posttests. They also earned an average of 84% and 78% of the points available for paragraph organization in the two studies on posttests, respectively. Moreover, like the Schumaker (2020) study, the current study showed that students can learn to create a planning diagram for paragraphs at close to 100% correct performance. Also, like the Schumaker et al. (2019), 2019, 2020) studies, this study showed that the multimedia program was similarly effective with junior and senior-high students and girls and boys.

Third, the current study and previous studies (Schumaker et al., 2019, 2019) have shown the interscorer reliability, stability, and sensitivity of the measures that have been used across these studies. With regard to stability, in the current study for example, the academic-skills group and the normative groups showed that the pretest and posttest scores stayed relatively the same across a whole school year, demonstrating their stability. Meanwhile, the measures for the students in the experimental group changed substantially and significantly, demonstrating their sensitivity to growth.

The results of this study extend the previous research in several ways. First, in the current study, two genres of writing are represented for both paragraphs and themes: persuasive and narrative writing. In previous studies, only one type of theme writing was emphasized. Ray et al. (2018) focused on argumentative (persuasive) theme writing, and Schmidt et al. (1988/89) focused on informative theme writing. Second, this study is the first to show that students can learn to write themes using an interactive multimedia software program. The Schumaker (2020) study focused only on sentence and paragraph writing. Third, this study adds some normative data on new measures to the secondary literature. Normative data were previously reported for commas skills (Schumaker et al., 2019) and punctuation skills (Schumaker et al., 2019). This study adds sentence-writing scores, paragraph- and theme-planning scores, and paragraph- and theme-writing scores to the mix.

Limitations

This study is limited because of several factors. The students were volunteers who participated on their own time and were paid hourly for their participation. Also, the instructor who monitored their use of the software programs and provided feedback on their writing samples was an experienced teacher who had taught the writing strategies in a live instructional setting. Additionally, the students worked under scheduling conditions that are different from typical school conditions. Interestingly, the large majority of students only needed to create one (or at the most two) writing samples before reaching

mastery when they were practicing paragraph and theme writing. Thus, the amount of critical feedback they received and the amount of live instruction provided by the instructor was minimal. How students working under typical school conditions would react to the software programs is not known. Presumably, they would be working daily instead of once or twice a week, which might make a difference in their satisfaction ratings. In the research setting, the students worked as long as they wanted (often for 2 or 3 hours) and left when they completed work on a given segment or when they needed to leave. In a school setting, they typically would not have that type of freedom.

Moreover, the amount of training that inexperienced teachers might need in order to be able to produce the same results is not known. They would need to learn how to score paragraphs and themes and how to provide feedback to students on their final written products in each program, as well as how to monitor students as they work on computers. Since there was no way that students could "break" the programs or cheat within the programs, such monitoring is minimal unless students begin using their computers to do other tasks or use the Internet. Thus, the majority of teacher training would have to focus on scoring and feedback related to the students' performances.

Another limitation relates to the time spent while working through the software programs. Although most of the students completed all the programs assigned to them and spent the whole school year doing so, the time spent by the academic-skills students on the six software programs is not known. Only the time spent by the writing students was recorded as a fidelity measure. Ideally, the time spent within the respective interventions should have been equivalent. However, because of the mastery factor, students spent varying amounts of time on each of the groups of programs, and the time varied widely (28.5 hours versus 103 hours). The student who spent the least amount of time met mastery on his first attempt at each quiz and practice activity. The student who spent the most time required numerous practice attempts on each activity to reach mastery. Future studies of this type should not only measure the length of time spent by students in both interventions but should also gather more information on the actual number of practice attempts and errors made.

Also, the students in the writing group obviously spent more time engaged in writing than the students in the academic skills group and normative groups. Students in the writing group wrote some paragraphs and three themes as they worked through the writing programs. However, all the students were enrolled in school during the whole year and presumably did some writing as a part of their coursework. Moreover, because the students in a previous Schumaker (2020) study wrote several paragraphs across the multiple-baseline design and their performance did not improve, performance improvement across many writing samples does not seem likely. Future studies might consider making the number of writing tasks equivalent across the groups in some way, although this would be a difficult study to conduct given the reluctance of administrators to spend precious instructional time on testing tasks.

Future research

Future research needs to focus on using the software programs in schools and other service settings, such as Boys and Girls Club, after-school tutoring centers, remote-learning situations, and summer school settings under the typical conditions present in those settings. Additionally, future research might focus on whether student performance can improve above the results achieved here if students complete more practice attempts on paragraphs and themes and on whether they are able to generalize their newly learned skills to general-education coursework, standardized tests, and state writing competency tests. Does their use of these programs yield differences in the quality of students' lives? Are they more likely to graduate from high school and post-secondary educational settings? Future research might also focus on more complex types of writing than the basic writing that was taught in the present programs and on creative ways to vary writing structures and organizations. For example, multimedia programs might be built for the kinds of writing that are used in science courses or history courses.

Because one of the more interesting results of this study involved the use of normative comparison groups and showed that normative students' writing performance did not improve across a school year and was similar to the pretest performance of the experimental subjects in this study, future research might focus on measuring the writing skills of normative groups in a variety of schools and locations. Some schools might be better than others in terms of producing improvement in student writing over time. The normative results of this study and others (Schumaker, Fisher, & Walsh, 2019; Schumaker, Walsh, & Fisher, **2019**) can serve as baselines for other studies.

Because other researchers (Berninger et al., 2009) have found that students take more time writing sentences and essays when using a keyboard versus pen, future research might explore this variable after students have worked through the multimedia programs used in this study. That is, does use of the multimedia writing programs make students more proficient at using the keyboard while writing when compared to using a pen? This variable was not possible to explore in this study because all the experimental students used keyboards while they used the multimedia programs, and they all used paper and pencils to take all the tests.

An important caution is in order for future research. This caution relates to the magnitude of the difference shown in the current study between pretest and posttest scores. In the current study, a one-point mean difference was found to be statistically significant for the academic-skills group. However, a one-point difference in test scores might not mean much in terms of the quality of students' lives in the long run. Future researchers might not only focus on the statistical significance of their results but also the social significance (Wolf, 1978) of their results. This means relating performance gains in writing to performance in coursework and on standardized tests and competency exams.

Implications

The existence of multimedia writing programs, paired with the positive results they can produce, present new options for schools and writing instructors. Since NAEP results indicate that students' writing skills are generally poor, and since research shows that the writing skills of low-achievers and students with learning disabilities do not improve across the secondary grades (Warner et al., 1980), educators need ways to improve those skills to meet state and national standards. "Business as usual" is not creating the results needed, as shown through the way the academic-skills group and normative samples did not improve in this study. Clearly, new ways of providing writing instruction that is evidence-based and proven to work, like the software programs tested herein, need to be utilized. Perhaps even a new vision of schooling is needed that incorporates computerized instruction for students at their skill levels regardless of the grades in which they are enrolled. If they cannot write complete sentences, a software program designed to teach that skill with fidelity needs to be made available to them until they reach mastery. Then they can progress to the next level of writing skills with access to a new program. Such a skills-based program relies on school schedules to be highly flexible and the placement of students in various skills programs to be fluid. It also relies on students having daily access to the right kinds of computers that allow interactivity between the student and the software programs. Nevertheless, because multimedia programs allow for perfect fidelity of instruction and can be designed to insist on the mastery of skills, teachers will be able to focus on giving students the kinds of feedback they need to improve their written products. Only when these evidence-based types of instruction become readily available will the large majority of students be able to meet the writing standards set forth for them.

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Disclosure statement

The multimedia programs tested in this research are commercially available..

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