Underutilized Technology Solutions for Student Writing

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Abstract

This article provides key considerations and step-by-step procedures useful for any teacher to use when planning to enhance their writing instruction with technology. This includes understanding current writing initiatives as well as recognizing the common behaviors of skilled and struggling writers. Four types of underutilized, yet commonly available technology families are described with associated online tool exemplars. These tools can be used during writing instruction across educational settings to support varying student needs. Recommendations are also made for a step-by-step approach to embedding technology within various components of writing (i.e., prewriting, research, drafting, editing, proofreading) that allows for implementation of writing strategies paired with commonly available technology. Finally, guidelines are shared to support teacher planning and implementation of effective writing strategies supported with technology.

Keywords

technology, writing, intervention, academic strategies, learning strategies, learning disabilities

Investments in technology tools and one-to-one initiatives, such as providing one Chromebook for every student, are increasing student and teacher access to digital devices. K-12 schools spent over 14 billion dollars on technology in 2018, up nearly 2 billion from 2016 investments (Education Week Research Center, 2017). Among these growing digital solutions are tools that support and facilitate the writing process, particularly for struggling learners and those individuals with disabilities (Bouck et al., 2015). While some tools might be deemed traditional assistive technologies (ATs), most are simply technology-based solutions (e.g., built into a keyboard, apps) that facilitate word generation, improve fluency, organize one's thoughts, assist in generating ideas, work to address spelling challenges, and support the overall mechanics of writing. Many of these types of tools have been available for years, being updated and becoming more accessible as technology improves. Indeed, there is now a legal mandate in American public schools that requires educators authoring an individualized education program (IEP) for any student identified with a disability to consider and indicate how technology could assist them in learning (Individuals With Disabilities Education Act, 2004).

The purpose of this article is to provide step-by-step procedures to support teachers when planning to enhance their writing instruction with technology. It begins by offering key considerations for teachers when planning their approach to writing instruction. These include information on current writing initiatives and common behaviors of skilled and struggling writers. Presented next are commonly available, underutilized technology that can be used to support varying student needs in writing instruction across educational settings. Highlighted next is how various components of the writing process can be better supported by pairing writing strategies with recommended technology. Finally, a decision-making model for teachers is offered to support their

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Table 1. Characteristics of Skillful Writers Versus Writers Who Struggle.

Skillful Writers	Writers Who Struggle
Demonstrate automaticity in generating ideas	Experience difficulty in **generating ideas**
Plan their writing	Are unlikely to **plan** their writing
Have automaticity with handwriting and spelling	Experience **handwriting and/or spelling difficulties**
Are familiar with the rules of grammar and the mechanics of writing (e.g., capitalization, punctuation)	Make numerous errors in **grammar and writing mechanics**
Have knowledge and understanding of writing genres (e.g., story writing, persuasive writing)	Have limited knowledge about **writing genres**
Are comfortable searching for and using outside information to inform and support their writing	Are uncomfortable **searching** for and using outside information to support their own writing
Are motivated and persistent during the writing process	Are not **motivated** to write
Actively use strategies to monitor, revise, and edit their writing	Have limited knowledge of **writing strategies** and spend minimal time on **revising** or **editing** text

interventional design process pairing effective writing strategies with technology.

Considerations for Writing Instruction

Increased Focus on Writing

As access to technology has increased in recent years so has the call for increasing the focus on writing instruction. The National Council for Teachers of English Report on Writing for the 21st century (Yancey, 2009), the National Assessment of Educational Progress Report on Writing (U.S. Department of Education, 2012), and a series of reports from the Carnegie Foundation (Graham et al., 2011) include an emphasis on the inclusion of effective instructional strategies and assessment of student writing outcomes. While this emphasis on teaching writing across content areas has been acknowledged in practice, writing performance results for students with disabilities lag behind the results of peers without disabilities. Specifically, a 41-point gap in mean writing scores has been found between students with/without disabilities on the eighth-grade and 12th-grade assessments (U.S. Department of Education, 2012). Intervention solutions supporting writing instruction that lead to increased outcomes for students with and without disabilities are necessary.

Greater Access to Technology

With a greater emphasis on teaching writing and the growth of digital innovations, research has increasingly found the positive impact partnering the two can have on writing outcomes for struggling learners (Sung et al., 2016). Indeed, for students to write without a digital device is increasingly rare. Digital standardized assessments and textbooks continue to push school districts toward one-to-one (i.e., one device to one student) initiatives (Herold, 2014). Technology tools have been shown to be effective in supporting writing.

What still needs investigation is how best to combine writing instruction with technology-based supports in order to benefit struggling writers and students with disabilities (Berninger et al., 2015).

Strategy Instruction

While technology tools are becoming the norm (Herold, 2014), struggling writers also require specific instruction. For struggling learners and their peers with disabilities, writing instruction should emphasize explicit, direct, and systematic instruction with opportunities for learners to engage in meaningful, extended writing (Graham et al., 2017). Many evidence-based instructional interventions have been shown to facilitate the writing process. Examples of these can be found through the strategic instruction model (SIM) at the University of Kansas, Center for Research on Learning (https://kucrl.ku.edu) or the self-regulated strategy development (SRSD; Graham, Harris, & Chambers, 2016).

Writing Behaviors

When initially planning writing instruction, educators should be mindful of characteristics of skilled and struggling writers (Graham et al., 2014). Skillful writers demonstrate strong idea generation and planning, grammar and mechanics, and revision skills (Santangelo, 2014). Table 1 synthesizes the behaviors of both skilled and struggling writers. Understanding behaviors demonstrated by students while writing is useful for teachers to assess interventions and technology that may help in supporting students. These behavioral profiles found in Table 1 assist teachers in contextualizing writing instruction and grade-level expectations to meet the unique needs of their classroom. A writing behavior profile should be paired with evidence-based practices like the strategies from SIM or SRSD and supported through technology to enhance writing instruction for learners with and without disabilities.

Table 2. A Brief Selection of Technology Solutions for Writing.

Family	Solution	Description	Location
Interactive graphic organizers	Inspiration	This is one of the most popular interactive graphic organizers on the market. Available across platforms and devices, Inspiration offers a junior version (Kidspiration) and an array of features, including color, patterns, and images	Available online: http://inspiration-at.com
Interactive graphic organizers	Popplet	Available across platforms, this interactive graphic organizer supports free and customizable concept mapping	Available for free: http://popplet.com
Speech-to-text	Built-in for Digital Devices	Most smartphones, iPads, Chromebooks, and personal computers have free speech-to-text built-in where a user can speak into a microphone and text appears automatically	For more details: https://understood.org/en/school-learning/assistive-technology
Speech-to-Text	Dragon Naturally Speaking	One of the more intelligent speech-to-text applications available across platforms, Dragon is fairly attuned to the fluency challenges of many learners with disabilities	Available online: http://nuance.com/dragon
Text-to-speech	Write Outloud	Part of the Don Johnston suite of tools, this application is for Macs and Windows operating systems and offers a customizable tool bar, text-to-speech for nearly every function, an audio spelling and homonym check, highlighting, and speech output per letter, word, and sentence	Available online: http://donjohnston.com/writeoutloud
Text-to-speech	Read&Write for Google	A Chrome app that increases the accessibility of the text of documents in a Google Drive account with a talking dictionary and the app also reads the text of documents aloud. A vocabulary tool is included	Available for free: http://chrome.google.com/webstore
Word prediction	Co:Writer Universal	Co:Writer is available across platforms. Being one of the most mature word prediction applications, it offers features to support word generation, fluency, and spelling. Co:Writer will generate a list of commonly used words, specific vocabulary lists, and terms regularly used by the writer	Available online: http://donjohnston.com/cowriter
Word prediction	Texthelp	Available across platforms, Texthelp offers a number of supports, including word prediction. Texthelp offers lists of words, audio output, and words generated based on a specified vocabulary list.	Available for free: http://texthelp.com

Supporting Writing With Technology

Supporting instruction with technology is not a new concept. Supporting instruction with technology can increase student engagement, teacher and student efficiency, and ultimately student outcomes (Sung et al., 2016). Many districts have replaced traditional computer labs with Chromebook and iPad mobile carts allowing regular student access (Molnar, 2019). Thus, access to technology is not the primary barrier. Instead, the challenge teachers face is determining which app (i.e., application) or software to use, when to use it, and how to reinforce instruction when implementing the technology. Research has identified four families of tools to be highly effective in improving writing outcomes for struggling learners and their peers with disabilities (Okolo & Bouck, 2007). These families of tools are grouped under (a) speech-to-text, (b) word prediction, (c) interactive graphic organizers, and (d) talking word processors (e.g., text-to-speech). By focusing efforts on mastering these four tools, many teachers can improve the outcomes of their students in writing. A summary of each family of tools follows with sample tools for use as shown in Table 2.

Speech-to-Text

Speech-to-text is a solution for students who can sit and verbally relay their thoughts but struggle to type or write them. Speech-to-text tools help students focus on generating ideas for their essays rather than struggling with the physical and mechanical demands of the writing process (Higgins & Raskind, 2000). Recent advances in technology have led to further speech-to-text options, better supporting learners with poor fluency, and speech articulation (Bone & Bouck, 2017). Many devices such as smartphones, iPads, Chromebooks, and personal computers have built-in speech-to-text capability allowing for variability in student speech rate, tone, volume, clarity, and overall articulation.

Interactive Graphic Organizers

Another tool found to be effective with struggling writers is interactive graphic organizers. Skillful writers demonstrate automaticity in generating ideas (see Table 1). For many students with disabilities, generating ideas, organizing the ideas into coherent thoughts, and sequencing the

ideas to meet the requirements of the writing task represent major challenges (Graham, Harris, & Chambers, 2016). Interactive graphic organizers allow students to represent ideas and organize thoughts using different shapes, images, and graphics with arrows and lines that link various ideas and concepts (Dexter & Hughes, 2011). Students can replace text with visuals that represent their ideas, manipulate those visuals, connect their ideas, automatically convert their visual map into a traditional outline, and, finally, export it to a word processor.

Word Prediction

A third tool found to be effective with struggling writers is word prediction. Word prediction helps students who struggle with vocabulary, fluency, and typing (Ok & Rao, 2019). For instance, students may experience spelling challenges, have difficulty identifying the correct word, or who have limited vocabulary and repeatedly use the same words in their writing. Word prediction aids learners so that instead of laboring over how to spell a word, students can be taught to use suggestions made by their device and select the one that works best for them (Peterson-Karlan, 2011). Beyond simple word prediction, some writing tools (e.g., Co:Writer) have smart-vocabulary and/or word bank options where the user can indicate the topic they are writing about and the tool will predict words related to that topic. Word banks are helpful to students who are writing about a certain period or event in history, a particular novel, or a specific science concept. A typical word prediction tool is less likely to accurately predict names or places, but smart-vocabulary functionality makes word prediction even more helpful and specific for a user.

Talking Word Processors

The fourth tool found to be effective with struggling writers is a talking word processor (e.g., text-to-speech). An accessibility tool in most device operating features, talking word processors are applications that read the digital text to the user. Text-to-speech reads emails, digital books, presentations, and typed words. At its basic level, any text highlighted or otherwise selected by the user will be read aloud. The speed, volume, and digital voice can be altered by the user. Hearing the text read aloud is an excellent first step, but for students with learning disabilities (LDs) and those struggling with learning and attention issues, seeing as well as hearing the text is often critical (Ok & Rao, 2019). Text-to-speech is especially helpful for students during the peer editing process. Hearing errors in writing makes locating and fixing them easier and more efficient (Cannella-Malone et al., 2015). For more information on talking word processors and the other three technology families, see Table 2.

Technology and the Writing Process

Speech-to-text, interactive graphic organizers, word prediction, and talking word processors are readily available on most digital devices and yet, they may not be the go-to technology solution for teachers when helping students who struggle with writing. The following recommendations are organized by five components of the writing process (Graham, Bruch, et al., 2016) and highlight specific technology solutions and classroom examples to support future implementation of these tools. Each component of the writing process described here aligns with technology supports and is illustrated through a vignette of Jackson, a seventh-grade student with LD (see Note 1).

Component 1: Prewriting (Thinking and Deciding)

Prewriting is one of the first steps of the writing process. For learners with LD and other disabilities, this can be a very difficult step (Graham et al., 2014). Sorting through potential topics, understanding the expectations and parameters of the writing task, and determining a path to support moving forward with the writing task can be daunting for struggling writers (see Table 1). Struggling writers have difficulty generating ideas and planning their writing tasks (Schumaker & Deshler, 2009). Utilizing technology supports can assist struggling writers with the difficult step of getting started. Tools like interactive graphic organizers and speech-to-text help a student get their thoughts into a visual form quickly. Interactive graphic organizers (see Table 2) such as *Inspiration* (Inspiration Software, Inc, 2020) and *Popplet* (Notion, 2020) encourage students to map their thoughts through brainstorming keywords and phrases in small bubbles. Students can then drag and drop their bubbled thoughts into larger categories of similar ideas and draw connections where needed. Speech-to-text can be paired with interactive graphic organizers so that students can simply speak their thoughts and not have to use their cognitive load to generate text.

For example, seventh-grader Jackson has an identified LD and has always struggled transferring his thoughts to paper. He is more successful expressing his ideas by sharing them orally with the teacher while she transcribes. Speech-to-text makes this process more efficient and independent. Jackson can press the microphone icon on his keyboard and speak the words that he wants for each bubble in his Inspiration concept map, no longer relying on the teacher to write on his behalf. Jackson no longer has to focus on how to spell the word or remember what the word starts with, he can just say what he is thinking and it appears. Speech-to-text and interactive graphic organizers can help students who struggle to produce text and ideas to successfully begin the writing process.

Component 2: Research and Synthesis (Evidence and Examples)

Once a student has chosen an idea to write about, they must find more information about the topic. The act of researching is widely supported through technologically based search engines for those with and without disabilities (Google Scholar, Bing, Chrome). However, conducting research through this technology can be daunting simply by the amount of information accessed through technology search engines. Students who are struggling writers also tend to be struggling readers (Graham & Hebert, 2011). Locating and synthesizing evidence and examples to support the ideas that were initially generated in prewriting can add a layer of frustration to the writing process. Technology tools such as text-to-speech can be helpful here.

For example, if Jackson pulls up an internet browser such as Chrome and uses speech-to-text to enter a search term, he can also be taught to use text-to-speech to have the article read to him. Once he hears a segment of text that supports his idea, he can speak a summary in his own words into a bubble in his graphic organizer, which he can then use as he develops his outline. Using supports within research databases and systems can support students like Jackson to navigate those systems and effectively find information they need to inform their topics.

Research and synthesis should end with an outline. This outline creates a visual step-by-step plan of action for the student. It supports the flow of the writing and provides a first glimpse to determine whether the student is meeting the expectations of the assignment. Technology can support this component of writing as well, especially the program, Inspiration. Built into Inspiration is the ability for Jackson to create a concept map with bubbles and lines and then with the push of a button, the program automatically transforms the concept map into an outline with headers and supporting evidence listed in bulleted, outline form. Jackson can then export the Inspiration outline into a Word document in preparation for drafting. By pairing text-to-speech for research online with an interactive graphic organizer for note-taking, Jackson and other students can take advantage of technology to more easily search and organize the content they need to begin another component of the writing process, that of drafting.

Component 3: Drafting (Write)

After an outline has been created and approved, a student can begin drafting their paper. This component includes utilizing the findings of any information discovered in their research as well as using their outline as a blueprint for the construction of their paper. Struggling writers may have difficulty putting their ideas into text (see Table 1). They may struggle with the technical aspects of writing. Technology can be used to support this drafting process. For example, if a student has copy and pasted their outline from Inspiration and now needs to begin generating paragraphs, they may still struggle with coming up with the words they need to fill in the empty space. Text-to-speech can be used to initially generate text with spoken words, but students may also benefit from a more conscious use of word prediction. Some writing programs such as *Co:Writer* have a vocabulary-smart function built-in so that a student can indicate the topic of their writing and the system will automatically predict words associated with that topic.

Jackson struggles to spell, but he can typically generate the first letter in the word he wants to type. By enabling word prediction, Jackson can type the first letter and the program will provide him three or more words for him to choose from, depending on the word prediction tool he is using. In addition, Jackson can also use a vocabulary-smart word prediction tool to predict topic-specific words. For instance, if Jackson is writing about knights of the middle ages, he can enter "middle ages" as a writing topic in Co:Writer's word bank feature. Then, if he wants to type the word "knight," phonetically, he may type the letter "n" instead of the silent "k." As Co:Writer is predicting words based on the middle ages, even though he types an "n," the word "knight" will be suggested, due to his use of the topic-based word bank feature. Similarly, the word Pharaoh phonetically sounds like it begins with an "f," but topic-based word banks on Egypt would predict the word Pharaoh when a student types an "f." Word prediction and vocabulary-smart word prediction can help students like Jackson find illusive words so that they can focus on their ideas instead of laboring over production of text.

Component 4: Revising (Make It Better)

Revising or monitoring is a critical aspect of the writing process, but it depends on the ability to evaluate one's own work and make improvements when needed. Struggling writers may not be confident in their ability to monitor their work or may not have the skills to evaluate the content of their work adequately (see Table 1). When revising, ensuring the content of the paper addresses the main ideas provided in the outline is critical. Technology can be used to support this monitoring process. Teaching students to refer back to the original concept map can support students to self-monitor whether or not they have included all the concepts and supporting evidence that they outlined for the draft. This is especially important whether a student used Popplet or another interactive graphic organizer tool to generate their initial ideas for a piece of writing. In the transfer from a concept map to a draft, ideas and information could be misplaced or forgotten.

For Jackson, he was able to transfer his original outline from Inspiration to Word. He can still use the original

Inspiration interactive graphic organizer to confirm that none of necessary content or ideas that he wanted to include were not inadvertently omitted during the drafting process. Using the interactive graphic organizer as a monitoring checklist can support students like Jackson who struggle to include all of the pieces needed in their final draft.

Component 5: Editing and Proofreading (Make It Correct)

One of the final components in the writing process concentrates on the technical aspects of writing. For struggling writers, spelling, sentence construction, paragraph flow, and so on, are all areas that may be difficult (see Table 1). Editing and proofreading can support a finished product that meets expectations. However, struggling writers may need support editing and proofreading. Technology can be used to support this process as well. Text-to-speech is an invaluable resource for the revision process. Text-to-speech helps students hear errors in their writing that editing through a student's own reading would not have caught.

For instance, frequently Jackson will read his own work and comprehend it the way he thought he wrote it. By teaching him to use text-to-speech during the revision stage, he has the device read the text to him aloud so that he can listen for moments where the text may not make sense. For instance, it may be missing a word that when he read it himself, he missed recognizing the omission. By hearing it aloud, it becomes apparent he needs to add or clarify.

These five commonly used components of writing (Graham, Bruch, et al., 2016) integrated with technology can support struggling writers to be more successful in their writing tasks. By focusing on these four families of technology, teachers can establish a ready set of tools to support struggling writers when needed. Still, teachers need a way to determine which tool is most appropriate to support specific writing interventions. The following decision-making model can be beneficial to support this process.

A Model for Selecting a Technology Solution

Selecting the best technology to pair with writing interventions requires a decision-making model. Teachers can use the six steps provided here to guide those decisions.

Step 1: *Review the current initiatives and emphasis areas for writing instruction within the local district and supplied by various reports on writing instruction.* Several resources supply updated information on evidence-based practices in writing. A most commonly used resource is the What Works Clearing House (https://ies.ed.gov/ncee/wwc/). When evaluating appropriate writing strategies for implementation, teachers should ensure the strategy (a) has an evidence-base (i.e., has been shown to be effective with the population targeted for instruction), (b) is something that can be implemented in the environment and with the resources available, and (c) requires no additional training or that free training for implementation is available through online modules, readings, or other resources.

Step 2: *Review the identified behaviors of skilled and struggling writers.* Earlier, we supplied a summary of the behaviors of skilled and struggling writers, also found in Table 1. Teachers should consider these behaviors and compare them with the characteristics of the skilled and struggling writers in their own classroom. Strategies that best support the needs of the learners should be selected.

Step 3: *Select the instructional approach and accompanying strategies, reviewing the fundamental steps of each.* Once Steps 1 and 2 have been completed, teachers are ready to select their instructional approach and accompanying strategies. At this point, if a teacher has not been trained in the strategy, they should seek additional training and/or information to make sure they can implement this strategy with fidelity. See Table 3 for examples of effective evidence-based writing strategies.

Step 4: *Study the four most commonly used technology tools supporting writing instruction, selecting when and where throughout the intervention each tool may enhance instruction.* See the descriptions in this article and Table 3 for suggestions on combining technology with selected writing strategies.

Step 5: *Implement the solution.* Once a teacher has selected the instructional support and associated technology tool, they should test these with the student(s) they have identified. Ensure the instructional support and associated technology tool are being used as the research supports them and that the teacher has taught the use of the strategy and the tool to mastery.

Step 6: *Measure effects and adjust where needed.* Depending on the frequency and intensity of use, determine whether the targeted skill is improving and if not, make adjustments. If a foundational skill (e.g., spelling, mechanics, grammar) is being measured and a progress monitoring tool that automatically scores student samples is needed, see writingclassroom.org.

Embedding technology into components of the writing process better supports learners who struggle with writing. Teachers who use the decision-making model above can better align technology supports with writing, creating better outcomes for students.

Conclusion

The four technology families presented here are not new. However, using them to support the five highlighted

Table 3. Strategy Integration With Technology to Address Student Writing Challenges.

Writing Challenge	Writing Strategy Application	Technology Application
Idea generation	TREE strategy reminds students to think about topics before they begin to write and prompts them to include the essential elements of a paragraph	Interactive graphic organizers can help learners visualize ideas in the form of words, symbols, and images. The tool can be used as a precursor to sentence and paragraph construction using TREE
Planning	C-SPACE strategy encourages learners to include the essential elements of a story	Speech-to-text software can allow students to focus on addressing the essential story components via dictation
Handwriting and/or spelling	COPS strategy ends by prompting students to check for mechanical errors, such as spelling	Typing in general can compensate for handwriting difficulties. Word prediction brings spelling errors to students' attention
Grammar and mechanics	COPS strategy reminds learners to check for mechanical errors, such as spelling, capitalization, and punctuation	Word prediction can interpret spelling and grammar mistakes and offer word suggestions in real time Text-to-speech software can alert students to errors as they listen to their compositions being read to them
Writing genres	TREE is a generic writing strategy, but SPACE and STOP address specific genres	Interactive graphic organizer templates can help students brainstorm ideas for different writing purposes
Motivation	STOP, C-SPACE, and TREE are mnemonics that are designed to promote writing success	Text-to-speech can reinforce writing progress and enhance motivation Interactive graphic organizers can give learners the opportunity to be creative with visuals and colors as they plan and organize their writing
Writing strategies and revising	STOP and COPS are examples of writing strategies that include revision steps	Text-to-speech supports the revision process by allowing students to hear what they have written and help them identify errors

Note. The strategy acronyms are spelled out as follows TREE = topic sentence, reasons, ending, examine; C-SPACE = characters, setting, purpose, action, conclusion, emotions; STOP = suspend judgment, take a side, organize your ideas, plan more as you write (Harris et al., 2008); COPS = capitalization, overall appearance, punctuation, spelling (Schumaker & Deshler, 2009).

components of writing presented here offers a promising prospect to enhance student strategic writing capability by offering a range of applications to address specific needs within each component. Numerous advantages to integrating technology into writing instruction for students with LD and other disabilities have been shared, along with demonstrative models. Teachers can also use the six-step model of decision making provided here to plan writing instruction supported with technology. This will support educators' goals to achieve success in meeting grade-level writing expectations, thereby building the platform for college and career readiness.

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Note

1. The vignette of Jackson is a fictionalized account drawn from several authentic situations and put together as an aggregated scenario.

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