SPELLING AND ASSISTIVE TECHNOLOGY: HELPING STUDENTS WITH DISABILITIES BE SUCCESSFUL WRITERS

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ABSTRACT

Successful writers have proficient skills in three areas: handwriting, spelling and composition. Many students with disabilities experience difficulties in the area of spelling, which in turn may lead to difficulty in composing written work. Spelling deficits should be addressed by the student's Individualized Education Program (IEP) team to determine whether the student needs intervention, assistive technology (AT), or a combination of both to become a successful speller. This article describes evidence-based spelling supplements and assistive technology devices to help all students overcome spelling difficulties. Three examples of students who have composition problems exacerbated by poor spelling ability are described to illustrate the possibilities for spelling improvement.

SPELLING AND ASSISTIVE TECHNOLOGY: HELPING STUDENTS WITH DISABILITIES BECOME SUCCESSFUL WRITERS

The purpose of writing is to convey a message. For many students with disabilities, the ability to write effectively is challenged and impeded by misconceptions regarding the writing process, lack of direct and explicit instruction in

the elements of writing, issues with handwriting, and the inability to spell (Stein & Dixon, 1994). These students vary in their exceptionalities and vary in the reasons for writing problems. Students with mild learning and behavioral disabilities exhibit poor phonological processing skills that create writing and spelling difficulties (Pershey & Clickner, 2007).These same students are dependent on teacher-based external prompts such as the conventions of writing, teacher feedback, and format of the paper (Englert, Raphael, Fear, & Anderson, 1988). Students with mild mental retardation often lack the cognitive ability to master the complex phonological rules of spelling and also have problems with working memory and attention (Cardoso-Martins, Peterson, Olson, & Pennington, 2009). All which affect the students' ability to effectively write.

Students with physical disabilities have additional issues that challenge their writing. Best, Heller, and Bigge (2005) suggested that students with physical disabilities may be challenged by lack of motor ability, restricted participation and practice, lack of experiences, loss of the connection of reading and writing, as well as problems with the learning environment. When students with physical disabilities also have speech problems, the ability to convey a written message becomes a critical component in academics as well as the postsecondary environment.

Regardless of a student's disability, The No Child Left Behind Act of 2001 (NCLB) and IDEIA (2004) mandated that all students with disabilities have access to the general education curriculum. In order for students with disabilities to be successful with this curriculum, they must be able to write effectively. One element of the writing process is that of spelling. Reading is a decoding process while spelling is an encoding process. Students that have problems with reading often have problems with spelling (Hogan, Catts, & Little, 2005). Consequently, in an effort to avoid spelling errors, students may use less sophisticated and varied vocabulary in the writing process (Salend, 2008). Many students with intellectual, learning and physical disabilities have problems with spelling that interferes with the process of writing (Larsson, Sandberg & Smith, 2009; Sandmel, et al., 2009). Whatever the cause, spelling difficulties can be detrimental to the psyche of the speller. Graham (1990) contends that difficulty in spelling may hinder a student's fluency, proficiency, and self-confidence as a writer, thus affecting the final product.

When the act of spelling becomes demanding, students minimize their use of other writing processes, such as outlining or revising, because these processes require a considerable amount of cognitive energy. For students who have not yet mastered the mechanics of writing, consciously having to attend to those skills of getting language onto paper may consume the writer's

processing memory, interfering with higher order skills such as planning and content generation (Graham, 1990).

Teachers may also be frustrated as well. According to Johnston (2001), many general education teachers remained dissatisfied both with what they were doing (their spelling instruction) and with their results (students continuing to spell poorly). When teachers realize that traditional approaches to spelling may not be effective, they are often unaware of other instructional strategies, sometimes using trial-and-error techniques at the students' expense (Carnine, Silbert, & Kameenui, 1997).

The purpose of this article is to describe evidence-based spelling supplements and assistive technology (AT) devices to help students with disabilities overcome spelling difficulties that hinder effective writing. Students of all ability levels make a range of spelling error types. Regardless of error type, a range of spelling programs, web-assisted sites, and assistive technology devices can help to remediate those errors. A large part of error diagnosis comes from the teachers knowing what the needs are of each individual student. Three profiles of students with varying disabilities who have problems with the writing process exacerbated by poor spelling ability illustrate the possibilities for spelling improvement.

SPELLING SUPPLEMENTS

Many students with writing issues need additional spelling instruction. For students with learning difficulties the traditional approach to spelling may not be appropriate. Vaughn and Bos (2009) suggested that effective spelling instruction for many students who learn differently includes the teaching of spelling patterns, providing sufficient practice and feedback, selecting appropriate words, direct instruction, using instructional language, maintaining previously learned words, giving external motivation, and supplying dictionary training. Outside of the mechanics of writing, the actual ability to spell can also be problematic for nonspeaking students where phonological awareness is a predictor of spelling ability (Burt & Shrubsole, 2000). Spelling supplements offer options to teachers who recognize that many students need another approach to learning how to spell (or provide additional teacher-led instruction).

ASSISTIVE TECHNOLOGY

While the use of spelling supplements meets the needs of some students with disabilities, there are other students who require additional tools to obtain spelling instruction, demonstrate proficiency, and access materials and

varying learning environments (Bottos, Bolcati, Sciuto, Ruggeri, & Feliciangeli, 2001; Maccini, Gagnon & Hughes, 2002; Sitko, Laine, & Sitko, 2005; Strangman & Dalton, 2005; Wehmeyer, Smith, Palmer, & Davies, 2004). Recent studies have demonstrated that children with physical disabilities can benefit from access to literacy instruction which includes spelling instruction (Browder et al., 2006; Kliewer & Bilken, 2004; Koppenhaver & Erickson, 2003). The key to accessing the most appropriate AT lies in the ability of the Individualized Education Program (IEP) team to match the proper device to a student. In addition, the IEP includes AT services so that teachers and families know how to use the technology. IEP team members need to work together in providing effective adaptations for students with disabilities (Heller, Mezei, & Avant, 2008). Failure to do so may lead to AT abandonment. The following profiles of students illustrate the complexities of spelling difficulties as well as solutions.

Meet Hunter

Hunter is a 9-year old student in the 4th grade with difficulties in writing. He has a history of early childhood onset asthma. Generally, Hunter's condition responds well to medication and the use of inhalers; however, during seasonal times of the year, his allergies cause frequent and prolonged absences from school. Hunter receives special education services under Other Health Impairment. When Hunter is absent, he has a home-bound teacher and a lap top computer with a web-cam so that he is connected to his classroom. His classroom teacher and home-bound teacher collaborate well to help Hunter stay to learning. However, one problem that continues to be a struggle for Hunter is spelling. His poor spelling ability is beginning to affect his written composition skills. Hunter spends so much time and cognitive energy on spelling that he often looses the connection between writing and spelling. He also lacks practice opportunities with his peers when he is at home. Not only is his poor spelling affecting his grade, it is affecting his writing fluency. As he advances through the grades, fluency in writing will become a critical element in his academic success. Next year Hunter will take the state 5th grade writing assessment. His teacher wants him prepared for this high stakes test.

For a student like Hunter, there are a number of solutions that could help him become a successful speller. Hunter might benefit from spelling supplements or web-assisted sites.

Spelling Programs

Spelling supplements consist of two types, spelling programs and web-assisted sites. Spelling programs are beneficial when small group or individual

instruction can be scheduled for a student like Hunter. The web-assisted sites are used when schedules do not allow for individual attention; they can be used anytime throughout the day. Researchers agree that web-assisted sites should include remedial instruction and also incorporate compensation skills (Lovell & Phillips, 2009).

Hunter would benefit from specific spelling programs that have a wide scope of skill and practice. When the method of teaching spelling is given through the use of a series of commercial programs, the sequence of skills, vocabulary, content, and activities are determined by the authors of the series. Unfortunately, this method typically employed in accordance with the students' grade level, not their achievement level. Hunter would benefit from small group instruction that is matched to his spelling ability and needs.

The *Spelling Mastery* program (Dixon, Engelmann and Bauer, 2007) is one example of teaching students through the principles of direct instruction. This program emphasizes the importance of teaching letter-sound relationships. *Spelling Mastery* consists of six instructional levels (Levels A through F) with a total of 660 lessons. Lessons within each level are carefully sequenced so students like Hunter learn simple spelling strategies (letter-sound correspondences; regular words) before more complex spelling strategies (spelling rules, irregular words or strategies). Each lesson introduction is sequenced to minimize student errors. For instance, the letter *b* and *d* are introduced in separate lessons in order to avoid confusion. Over the course of many lessons, auditory and visual prompts are removed as students move into automaticity.

Hunter might also gain spelling skills from *Spelling Through Morphographs* (Dixon & Engelmann, 2001) which provides students with strategies and tools for spelling. The program teaches a small set of reliable, morphemically based spelling rules that enhance generalization to a larger group of unknown words. This program has shown to be effective and would be helpful when there are schedule constraints in a classroom (Burnette et al., 1999; Hesse, Robinson, & Rankin, 1983; Maggs, McMillan, & Patching, 1981; Robinson & Hesse, 1981; Vreeland, 1982).

If there is little or no time available for Hunter in small group instruction, *Read 180* (Hasselbring, Kinsella, & Feldman, 2009) is a valuable program that contains web-based instruction. It is an intensive reading intervention program that confronts the problem of adolescent illiteracy on multiple formats. The program directly addresses student needs through adaptive and instructional software, high-interest literature and direct instruction in reading, spelling, writing and vocabulary building. The program's multi-modal approach would provide a significant advantage for Hunter since the program has integrated video software, Universal Access

provisions, and audio books with paperbacks. They are all accessible from home when he is absent.

Read 180 provides multiple opportunities for reading, comprehension and spelling. This program allows students to produce recordings for self-assessment. Hunter would be able to receive automatic feedback enabling him to understand his mistakes. Text captioned videos also allow for read-alouds with modeled examples of fluent reading. When schedules do not permit for small group or individual instruction, web-assisted sites would be beneficial for a student like Hunter, whether at school or home.

Web-Assisted Sites

Many students are able to compensate for some academic deficits but often retain their spelling deficits well into their adult lives (Leuenberger & Morris, 1990). They may have developed compensation techniques that are time-consuming and frequently unsuccessful. Their successful strategy often involves seeking assistance from others. Effective web-assisted sites using speech feedback provided simultaneously with the typed word, and immediate correction, allow students to work independently with guided help.

Spellingcity.com is a web-assisted site which is an AEP Golden Lamp Finalist and Parents' Choice Award Winner. *Spelling City* has over 42,000 spelling words and ten spelling games. A person says each spelling word and uses it in a sentence. *TeachMe*, a component of the web-assisted site, spells and displays the word in ways that stimulate memory for visual and verbal learners. Printable worksheets for spelling practice can be created from any saved list. Choices include three sizes of lines, capitals or small letters, script or cursive, and directional arrows. This easy to navigate web-assisted site would provide the additional practice that Hunter needs.

Another helpful web-assisted site is spellingtime.com. The "Editor's Choice" award from *Children's Technology Review Magazine* is just one of countless awards that spellingtime.com has received. *Spelling Time* is a part of bigiqkids.com, which is host to a number of other subject area web-assisted sites. *Spelling Time* boasts a 23,000 word dictionary and 750 grade-appropriate word lists. Parents and teachers can easily enter word lists and *Spelling Time* will automatically create a week's worth of lessons, quizzes and tests. The program contains quizzes, spelling bees, practice tests, and fun spelling games all customized to a student's ability. Hunter cannot advance through the lessons without achieving mastery of each individual lesson.

Teachers should consider a number of things before making use of web-assisted sites. The number of computers available in a classroom versus the

number of students in that classroom should be calculated. The high cost of software and teacher time necessary to implement these web-assisted sites are also important factors. The computer can be a motivational tool that is a supplement to spelling instruction, but can be frustrating to some students. Hunter would first need direct instruction in navigating his web-assisted site. While students such as Hunter benefit from spelling supplements, other students with varying disabilities may need AT to provide access to the spelling supplements or need AT devices to compensate for poor spelling.

Meet Maria

Maria is an 8th grade student who was diagnosed with mild intellectual disabilities in the second grade. Maria is an active member of her basketball team and enjoys being with her friends. However, Maria reads at about a 4th grade level and works at a 5th grade level in math. Her writing skills are emerging but due to her lack of ability to spell words on her current grade level, she is unable to keep up with the complex academic demands in science and social studies. Maria participates with her typical peers in general education classes with accommodations and modifications. In addition, she receives special education services one period per day in the resource room for reading intervention.

Due to Maria's age and current level of performance, the team might consider both light and high tech devices for her. Within the school curriculum there are important words that Maria must recognize and use in completing assignments in science and social studies. Having the teacher highlight these important words and helping Maria understand the general definition will allow Maria to use the words in her work. There are numerous highlighting tools available for use both on consumable materials and non-consumable materials. Her teachers can help determine when and where it is appropriate for Maria to utilize a highlighting tool. Highlighting pens are available in a multitude of colors. The highlighting pen is most appropriate when the material is consumable. The teacher should explore with Maria which colors should be used for different purposes. For example: When Maria is given a diagram of a plant cell. One of the parts of the cell contains the *vacuoles*. The teacher may want Maria to highlight the term *vacuole* in one color and then the term *cell* found in the definition in another color.

For non-consumable materials such as the textbook, other highlighting tools are appropriate. Highlighting tape is available in many colors and widths. It can be applied to a word or a group of words. The tape can be written on

and is reusable. For example: Maria's teacher highlights the words *vacuole* and *cell* in the textbook. Maria can then copy the word by writing on the tape and then transfer the tape to another location such as her notebook paper where she can use it as a word box to write.

Another AT device that can be useful for Maria is the colored overlays. The acetate overlays allow Maria or the teacher to highlight important information that Maria uses in reports and other assignments. The overlays can be cut to the appropriate size for the particular assignment. Students can use this light tech AT device to transfer words to other documents.

In addition to and often in conjunction with highlighting tools, students can create a personal dictionary of frequently used words that they will need in their writings. This can be done in a notebook with lined pages, or a personal commercial dictionary. It has pages that are alphabetized and when the student encounters a word that is difficult to spell or has significance to a specific subject, the student can write the word in the appropriate place in their dictionary. For example: The word *vacuole* would be found in Maria's personal dictionary under the heading of "V". If Maria is also using highlighting tape, she can simply write the word from her text on the highlighting tape and transfer the piece of tape to her dictionary.

The highlighting tape and personal dictionary are examples of light AT devices. They are inexpensive as well as simple in their use. As AT devices become more complex, the IEP team must include AT services to insure that the student, teacher, and parent understand how to use the device.

The computer is a high tech device commonly found in most classrooms and in many homes; it contains word processing features, particularly the spell check feature. The use of word processing requires that a student have adequate keyboarding skills as well as knowledge of how to use the spell check feature. The spell checkers may be used both visually and auditorily. The pre-requisite skills needed by the student to use the spell check feature can be assessed and then taught if necessary. Otherwise, the best word processing software in the world will not be adequate to meet the needs of the student.

Portable word processors offer an alternative to the stationary computer. These devices are lightweight and easy to transport from classroom to classroom. Many of these mobile computers have text-to-speech features, word prediction, spell checker, and connectivity to other technologies. In addition to features that assist with spelling, the student would have access to additional tools that support successful writing.

Electronic spelling dictionaries provide another option for students. These AT devices allow students such as Maria to start to spell, or spell phonetically, to find

the words needed. Many of these devices also provide definitions and word uses as well as word alternatives. The devices are usually lightweight, portable, have speech options, and include quiet spelling options. Again, the student must be trained to use the device and how to generalize the spelling to improve writing. For many students spelling deficits are exacerbated by problems with motor skills. They may be unable to manipulate traditional writing tools.

Meet Joseph

Joseph is a bright 12 year-old in the 6th grade at a middle school. At birth Joseph was diagnosed with cerebral palsy affecting his gross and fine motor skills. In addition, Joseph has had frequent surgeries to promote stability when he walks. Joseph is a successful learner in all subjects except spelling; he has had adequate instruction in spelling but continues to struggle. In grades 4 and 5, Joseph participated in intensive supplemental spelling programs, but his 6th grade teachers see that he continues to have significant challenges in writing. They have asked Joseph's IEP team to consider AT devices to support his spelling and handwriting.

Like many students with physical disabilities, Joseph is bright and has had adequate instruction in various subject areas. However, his below average ability to spell fluently impacts his writing. His handwriting is a cause for concern but the team feels that an AT device might assist Joseph with both areas.

Since fine and gross motor skills are affected by Joseph's cerebral palsy, it seems that a high tech device can be the solution to support Joseph in both spelling and in the physical act of writing. All of the high tech spelling devices that were discussed earlier are valid choices to support Joseph's spelling. Again, desktop computers are readily found in most classrooms. However, it appears that Joseph may need additional AT to access the computer software in both the desktop versions and electronic dictionaries.

The IEP team must assess whether Joseph has the ability to use a traditional keyboard for operating the computer or whether he needs alternative input devices.

Alternative input devices, such as text-to-speech devices, allow students to type in a word on the monitor and have the word spoken to them. Speech-to-text devices allow the students to speak and the computer will display the text. Some students may benefit from alternative keyboards that accommodate for poor fine motor skills. Examples include communication overlays, touch screens, and redesigned keyboards. The occupational therapist will be the professional who can help with issues of key positioning and keyboard slope.

Figure 1

Five Questions for Alternative Keyboard Considerations

1. Is the alternative keyboard compatible with existing hardware?
2. Will the keyboard fit on the workspace of the student?
3. Can the keyboard be stored in a convenient place when not in use?
4. What are the specifications for the particular writing function? Some alternative keyboards change the function of certain keys or, in some cases, eliminate some keys altogether.
5. What training will the student, teacher, and caregiver need to utilize the keyboard? How long might it take before the student can fluently use the keyboard?

Adapted from U.S. Department of Health and Human Services, Public Health Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health (n.d.)

These devices allow the student to access the spelling features of the computer and electronic dictionaries. IEP teams will want to carefully consider the specific needs of the student when selecting an alternative keyboard. See Figure 1 for questions that guide keyboard considerations.

As mentioned earlier, high tech devices can be expensive. However, the operating systems of many computers have built-in accessibility features. While these features may not have all of the features needed by the student, it is good place to start. This allows the team to assess whether the student needs more sophisticated software or devices. By going to the *control panel* through the *start* menu, one can access the *accessibility* icon of a computer's operating system. Figure 2 is a comprehensive list of spelling supplements and AT devices with sources.

Graham (2009) suggests two recommendations for the success of AT devices for spelling. First, students are proficient with the AT device. Prerequisites must be taught first and then the students must be taught to use the device correctly. Others such as teachers and family members should also be trained on the operation of the device.

The second recommendation by Graham (2009) is to make sure that teachers do not confuse the ability of the student to use the device with the ability to spell and write. Students must be taught writing skills such as reviewing and revising their writing products. In addition, writing strategies should be part of the student's curriculum. The purpose of spelling is to be able to generalize the skill to the more complex skill of writing.

Figure 2

Comprehensive List of Resources			
	Title	**Description**	**Source**
Spelling Programs	Spelling Mastery	Emphasizes beginning spelling skills. From letter-sound correspondences to advanced spelling strategies.	Dixon, Engelmann, & Bauer, 2007
	Spelling Through Morphographs	Emphasizes spelling through morphographic units. Instruction focuses on prefixes, suffixes, and base words.	Dixon, & Engelmann, 2001
	Read 180	Emphasizes reading, spelling, writing and vocabulary building through interactive software.	Hasselbring, Kinsella, & Feldman, 2009
Web-Assisted	Spelling City	Emphasizes learning through 10 spelling games. Immediate correction with voice pronunciation.	www.spellingcity.com
	Spelling Time	Emphasizes custom quizzes, spelling bees, practice tests, spelling games. Has other subject area web sites.	www.spellingtime.com
Assistive Technology devices Light Tech → high tech	Highlighting Tape	A consumable product that is available in multiple colors. Can be written on and reused.	www.crystalsprings-books.com
	Colored Overlays	These acetate overlays are available in multiple colors. Can be utilized by learners to transfer words to other document.	www.nrsi.com
	Personal Dictionary	Students can list high frequency words and personal words that may be needed in writing.	www.curriculum-associates.com

Figure 2 *(Continued)*

Comprehensive List of Resources

Title	Description	Source
Word Processing Spell Check	High tech word processing features such as spell check enable students to correct and look-up words.	Word processing software of desktop and laptop computers
Portable Word Processing	Devices that are lightweight and easy transport from classroom to classroom.	www.renlearn.com/neo
Electronic spelling dictionaries	Devices allow student to start to spell or spell phonetically. Many have speech options.	www.franklin.com
Alternative keyboards	Input devices for computer keyboards that accommodate for poor fine motor skills.	http://www.ability-hub.com/keyboard/index.htm
Computer Accessibility Features	Devices can be accessed by using the operating systems of the computer.	Accessibility features can be accessed by going to the control panel of the computer. These are found on Mac and PCs.

Conclusion

Spelling and writing are complex skills. Many students with disabilities have deficits in spelling due to lack of instruction, cognitive difficulties, or developmental issues. All students may benefit from supplemental spelling instruction and web-assisted sites. However, there are students who receive adequate instruction as well as intensive, evidence-based spelling instruction but continue to struggle with spelling and consequently writing. These students may be candidates for AT devices.

There are a number of light-tech and high-tech spelling devices available for students who need support in spelling to improve writing skills. Always remember that choices for AT spelling devices should be made based on valid and reliable assessment of the needs of the individual student. This will ensure that the student has the correct device. Professionals who work with students who are struggling with spelling should assess whether the student needs supplemental spelling instruction or AT or may benefit from a combination of such.

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