Technology in Action

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Written Language: When To Consider Technology

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Technology tools can assist students with mild disabilities in the writing process, especially when used in conjunction with explicit instruction on use of the tools and strategies for writing. Find out how research is improving students' written achievement.

I went to my grndepants and mea nd my brower got to go swing. and arved day we rio bikes. we went to the fille and we drit stir. and we went oul to rat priy. and at chene weopn biott. the nesk day i was on my bike and i was ris and my bick got cart and rarovr sidw and omst got ran afer By a car. but prold tide. and then we went dack hom. wonst we got home we got to ump drinst, and we got lint limps. and me and my bive tok the crd out.

–Joshua, fifth grade

Each day, members of Individualized Education Program (IEP) teams support students with disabilities who have trouble writing. Many students with mild disabilities know what they want to write but have difficulty with the mechanics of translating those thoughts to paper. They often disregard language skills such as spelling, punctuation, and grammar. Some students' thoughts move so quickly that their writing seems to jump haphazardly from one topic to the next. Other students can spell and construct sentences but have problems generating and synthesizing ideas.

Assistive technology (AT) can be used to help these students improve their writing skills. IEP team members can use manuals or charts—for example, the *Assistive Technology Consideration Quick Wheel* (TAM and ILIAD, 2003)—to locate possible types of technology accommodations. Selecting the most appropriate tool involves analyzing the student's writing tasks, determining how technology might provide a viable accommodation, and considering the interaction of the tool and the student's skills. This ***TAM Technology in Action*** provides an overview of technology that can support written language.

Research to Practice: Technology Effectiveness and Written Language Skills

IEP team members should know the current research on the effectiveness of various technology tools in order to match student needs and abilities with the task and the setting. Described below are some of the tools that can be effective in helping students with learning disabilities improve their written language skills.

Technology and Media Division

Figure 1: Categories of Assistive Technology Devices and Software to Aid Written Language

Category	Description	Examples
Alternative Keyboards	Keyboards attached to the computer used instead of or in addition to the regular computer keyboard, configured for qwerty or alternative letter arrangement such as alphabetical order. Alternative keyboards are generally larger and can be placed at different angles for easier physical access.	Intellikeys - Intellitools Discover Board - Madentec Big Key - Fentek
Word Processing with Text-to-Speech	Applications that include all the options for word processing and also feature text-to-speech feedback. Users can choose speech feedback on individual letters, words, or sentences as they type or only when words are highlighted.	Write: Outloud -Don Johnston eReader - CAST Intellitalk 3
Word Prediction	Applications that are integrated as part of a word processing program or as a separate application in conjunction with word processing. Programs will predict the word being typed based on the content and frequency of word use.	Co: Writer - Don Johnston WordQ SoothSayer - AHF GUS! Word prediction EZ Keys - Words+ Telephatic - Madentec
Integrated Applications: Word Processing, Text-to-Speech, and Word Prediction	Applications that include features for word processing, text-to-speech, and word prediction.	Intellitalk 3 - Intellitools WYNN - Freedom Scientific Read & Write - textHelp WordSmith - textHelp Write Away
Speech Recognition	Users can control the computer and dictate to a word processing program using their own voice. Continuous speech recognition systems allow the user to dictate in a normal flow of speech.	Naturally Speaking - Scansoft ViaVoice - IBM iListen - MacSpeech

Figure 1 summarizes the categories of AT devices that are available and Figure 2 provides a list of vendors and websites.

Keyboarding and Alternative Keyboards

Students with mild disabilities and no physical limitations can use a regular keyboard to access the computer. Other students may benefit from an alternative keyboard with larger keys, spaces between keys, different arrangement of the keys, or keys that provide auditory feedback when touched. Regardless of the keyboard, however, students should have proper keyboard training before using word processing for writing (Wong, 2001).

Many elementary schools use keyboarding programs in their computer labs. Researchers report that students who use a word processing program to complete written products after learning the keyboard do better than students who do not have such instruction. They also say that students who use an alternative, larger than normal keyboard show a slight improvement over students who use just a normal keyboard (Lewis, et al., 1998). Keyboards that present the letters in alphabetical order do not enhance the process of writing because typing speed is decreased. In addition older students say the alternative keyboard is babyish and makes them look different.

Word Processing

Using a word processing program to create documents can help students who are hesitant about writing because they have poor spelling and/or handwriting skills. Word processing programs also can make it easier for students to correct and edit their written work.

Some teachers are concerned that word processing programs will automatically correct students' spelling and grammar, thereby eliminating the need to learn basic skills. However, studies of the effectiveness of word processing programs in automatically spelling for students with learning disabilities indicate that students must be able to begin a word with the correct letter and include most of the phonetic intent in order for the correct spelling to be provided (MacArthur et al., 1996; MacArthur, 1998a).

A comparison of the effectiveness of nine word processing programs in identifying typical target word misspellings found that none of the programs provided the target word within the first three words (Montgomery, Karlan, & Coutinho, 2001). Overall, the programs provided the target word an average of only 53 percent of the time, and the target word appeared first on the list only 21.6 percent of the time. Unfortunately, the students' correction rates only improve when the correct word appears within the top choices (MacArthur et al., 1996).

The writing of students who used a word processing program integrated with strategy instruction rather than handwriting did not improve in overall length, spelling, capitalization, or punctuation (MacArthur et al., 1995). The quality of narrative writing, however, did improve for students who had combined word processing and strategy instruction, although the word processing factor alone could not be singled out as the cause.

Word Prediction

Word prediction is an extended feature of word processing that provides suggestions for words to use. Many word prediction programs can be used in conjunction with any word processing program. Word prediction programs do not limit a student's creativity; rather, they suggest words based on the letters typed. The student is not required to choose any of the words predicted but can keep typing until the word appears in the list. Alternatively, teachers can add customized word lists to correspond with specific units or content.

Students who use word prediction do not need to be efficient in keyboarding. They can choose the word by selecting the number of the word in the list or by clicking on the word with the mouse. Many word prediction programs also include a text-to-speech component that allows the student to listen to the words before choosing and then hear individual words or the complete sentence spoken after the selection.

A growing body of research describes the positive effects of word prediction on writing tasks. Students who use word prediction show a decrease in the quantity of writing as compared to traditional writing but improve in the overall quality of their writing (Lewis et al., 1998). The use of word predic-

Figure 2: Vendors of Assistive Technology Devices and Software

AHF – Applied Human Factors	http://www.ahf-net.com/sooth.htm
AlphaSmart	http://www2.alphasmart.com/
Aurora	http://www.aurora-systems.com/
CAST	http://www.cast.org
Don Johnston	http://www.donjohnston.com
Fentek Industry	http://www.fentek-ind.com/bigkey.htm
Freedom Scientific	http://www.freedomsci.com
GUS	http://www.gusinc.com/wordprediction.html
IBM Viavoice	http://www-306.ibm.com/software/voice/viavoice/
Intellitools	http://www.intellitools.com
Inspiration	http://www.inspiration.com
Kurzweil	http://www.kurzweiledu.com/
MacSpeech	http://www.macspeech.com/default.html
Madentec	http://www.madentec.com/
ReadPlease	http://www.readplease.com
Scansoft	http://www.scansoft.com/naturallyspeaking/
TextHelp	http://www.texthelp.com
Wordq	http://www.wordq.com
Words+	http://www.words-plus.com/
WriteAway	http://www.is-inc.com/

tion with speech activated programs results in an even greater decrease in the overall speed of writing than does the use of word prediction alone.

Students using word prediction and text-to-speech software also have shown an increase in the number of words written and in the quality of journal writing completed (Williams, 2002). The students who used or accessed the word prediction program the most were the ones for whom the writing quality improved the most. Students who used a word processing program and word prediction for spelling, journal writing, and dictation could increase their spelling accuracy to the 90-100 percent range (MacArthur, 1998a; MacArthur, 1998b; MacArthur, 1999).

Text-to-Speech

Text-to-speech software is used to convert words in a computer into audible speech. Text-to-speech software can usually be configured to speak letters, words, or sentences as they are typed. Alternately, students can highlight and select specific words or sentences to be spoken. Many specialized word processing programs have text-to-speech capabilities. Some computer operating systems also allow users to activate features that allow them to hear highlighted text within a document.

Although no specific research has been conducted on the overall speed or efficiency effects of text-to-speech alone, listening to each letter or word as it is typed does increase the time required to produce each word, thereby decreasing the overall speed of writing. However, this can be offset by the fact that fewer revisions might be needed to complete the final product.

Speech Recognition

Instead of typing, speech recognition programs allow students to talk to the computer. The key to using speech recognition successfully is the amount of time spent training the system to understand particular nuances in the user's voice pattern. Considerations include the need to read the training material and train the system on particular voice inflections and the ability of the student to read incorrect words, select the correct spelling from an alternative window, sustain attention to correct mistakes, and work in a quiet environment.

The speech recognition system must be "trained" by each user to recognize words and sounds that are spoken into a microphone. Two types of speech recognition are available for use–discrete and continuous. Discrete speech requires the user to speak each word individually and distinctly. Continuous speech allows the user to speak more naturally, using complete sentences or phrases. An advantage of discrete speech is that the user can correct a word as soon as it is produced instead of waiting for a full sentence to appear.

The effectiveness of speech recognition has been a focus of research at the Frostig Center for several years (Higgins & Raskind, 1995; Higgins & Raskind, 2000; Raskind & Higgins 1999). Initial work, which concentrated on uses by post-secondary students with learning disabilities, found an improvement in expository compositions as compared to use of word processing alone or dictation alone. There also was an improvement in reading and spelling. Continued research with elementary and secondary students showed that discrete speech was more effective for increasing spelling and reading recognition than continuous speech.

Regardless of the type of system, students must be trained in its use, a process that can take as long as 10 weeks (Wetzel, 1996). In addition, students need to use speech recognition consistently over time (Higgins & Raskind, 2000). Further, students can benefit from pairing speech recognition with explicit instruction on the importance of preplanning thoughts or ideas prior to dictation (De La Paz, 1999).

A Case Study: Joshua

Let's take a look at how an IEP team might consider technology to support Joshua, a fifth grader. (See Figure 3 for a writing sample.) In this example, IEP team members organize their discussion according to the SETT framework (Zabala, 1995) that focuses on:

- **Student's skills**. These are functional areas of concern.
- **Environment and Tasks**. These are what the student is required to do. In this case, IEP team members will consider classroom assignments.
- **Tools**. This includes the available technology supports.

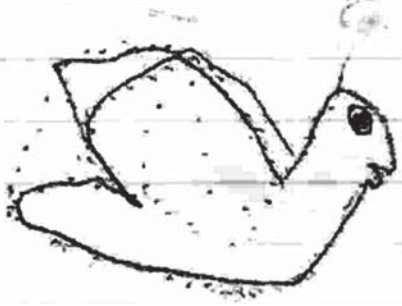
Student Skills

The example of Joshua's writing that was presented at the beginning of this chapter indicates that he has great difficulty with transcription and text production (e.g., formation of letters, spacing, spelling, and grammar). Joshua's teachers note that he frequently writes multi-page stories, so quantity or lack of a topic does not seem to be a problem for him.

An examination of the story content reveals that Joshua has problems developing a theme and keeping his plot consistent with his introduction. Sometimes he is too creative and jumps from one idea to another with no consideration of how they might relate. It also appears that Joshua has problems with the visual motor integration of writing. In the classroom, when copying from the board or a book, Joshua focuses on writing each word letter by letter, checking on the formation of each letter as he writes it. He is always the last student to complete his written work and he does not always have time to finish individual thoughts or sentences. He takes a long time to consider each letter and translate it from what he sees to what he must write. The time factor in copying certainly limits the amount of time he can attend to actual course content and instruction.

Figure 3: Writing Sample

I went to my grndepants and meand my brower got to go swing. and arved dau we rio. bikes. we went to the fille and we drit stir. and we went ou i to rat priy. and at chene we oupn Dirt. the nesk day I was on my bike and I was ris and my bick got cart and raroyr sidw and omst got ran afer By a car, but Prold t de. and then we went dack hom. wonst we got home we got to ump prinst, and we got lint limPS. and me and my brive tok the crd out.



Environment and Tasks

In sixth grade, Joshua will have to copy and take notes in the general education classroom and create written compositions in class and for homework. He will need to write assignments in his agenda. He will have to read and write answers to science and social studies assignments, labs, and tests.

Tools/Technology Supports

Joshua might benefit from strategies and tools that accommodate his spelling and handwriting difficulties. A technology plan might first include tools that could compensate for these two areas and then narrow down other related difficulties. Figure 4 presents software and devices related to specific writing tasks and skills that IEP team members might consider.

Given the complexity of Joshua's problems and his handwriting difficulties, the IEP team rejects low-tech options. For example, a pencil grip or wide lined paper do not address his spelling and grammar needs. The team members decide to consider:

- Word processing program with spelling checker.
- Word prediction.
- Speech recognition.

The following discussion describes how team members go about considering each possible tool.

Figure 4: Technology Tools Related to Tasks

Task	Considerations	Possible Technology Tools
Copying	Personal digital assistant (PDA).	Handheld or PDA AlphaSmart, Dana, Neo
Note Taking Writing with text-to-speech feedback for note taking and journal writing	Computer. Student would need headphones.	EReader - Cast Intellitalk 3 - Intellitools Kurzweil 3000 ReadPlease Write Away Write Outloud - Don Johnston WYNN - Freedom Scientific
Creative or Report Writing Writing with word prediction for creative writing	Combine word prediction with word processing for creative or free writing. Some software has dual capabilities.	Aurora CoWriter - Don Johnston Intellitalk 3 - Intellitools SoothSayer by APF Word Q Write Away WYNN
Creative Writing Speech Recognition	Speech mannerisms can make it more difficult to train. Training and practice are important. Need quiet space to work.	Dragon Naturally Speaking - Scansoft IBM Viavoice Ilisten - MacSpeech
Brainstorming, Organizing Ideas	Use in strategy and prewriting to help organize ideas.	Inspiration/Kidspiration Draft Builder - Don Johnston

Word processing program with spelling checker. Joshua cannot always read the words that he types. Given the advancements in word processing programs and devices, the team members review Joshua's writing with the available technology tools.

First, they conduct an analysis of Joshua's original writing. He had a total of 34 errors in 103 words, which represents 67 percent accuracy. [*Note:* This is comparable to the students in MacArthur's (1998b) study, in which students' baseline spelling rates were 42 percent to 75 percent.]

Next, they check the writing sample using Microsoft Word.

> *I went to my grndepants and me and my brower got to go swing. And arved day we rio bikes. We went to the fille and we drit stir. And we went out to rat priy. And at chene we oupn pitt. The nest day I was on my bike and I was ris and my bick got cart and rar ovr sidew and omst got ran afer by a car. But prold tide. and then we went dack hom. Wonst we got home we got to ump prinst. And we got lint limps. And me and my brive tok the crd out.*

Spelling suggestions that were generated included the following:

- bick (bike)
- sidew (sideways)
- tok (took –first word)
- ovr (over –first word)
- oupn (open – first word)

The program correctly identified 25 of the 34 incorrect words. Of the 25 words only five provided a choice for a correct spelling. Of those five, only three had the correct word listed first. Overall this spell checker feature was capable of identifying and correcting only 15 percent of the errors. Therefore, team members agree with the literature that, for Joshua—who has severe spelling problems—the spell checker feature in the word processing program most likely will not be able to predict the correct options.

In contrast, MacArthur et al. (1996) indicated that spell checkers can usually correct about one-third of the spelling errors. Thus, team members continue the analysis of Joshua's writing. They assume that if at least five of the errors are corrected, the accuracy of the passage would increase to 72 percent. Using Write:Outloud, a software program with text-to-speech capability, two additional word corrections were provided—with my grndepants (grandparents) and afer (over)—increasing Joshua's spelling accuracy to 74 percent.

Word prediction. Joshua's story was typed using Co:Writer and Microsoft Word. After each letter was typed, the number of guesses was checked to see if the correct word would appear in the list of predicted words. The option of five guesses was used.

> *I went to my grandparents and me and my brother got to go swimming. And arved day we ride bikes. We went to the fille and we drit stir. And we went out to rat privy. And at chene we open pitt. The next day I was on my bike and I was riding and my bike got cart and rar ovr sideways and almost got ran afer by a car. But probably tide. And then we went back home. Once we got home we got to ump prinst. And we got lint lamps. And me and my brother took the crd out.*

Joshua's writing yielded 17 errors, an 83 percent accuracy rate. Unfortunately, the team members did not know the effect word prediction and text-to-speech would have had on his ability to adapt his writing based on the feedback or if he would have changed words based on options. In addition, the team did not know the effect that specific training on word prediction basics would have had on his ability to use the program efficiently. They did agree that, with training, Joshua might find word prediction tools appropriate for long writing assignments.

Speech recognition. Finally, the team considers speech recognition. When Joshua was in second grade his parents worked to train him to use an early version of a speech recognition program. At that time, the program was not sophisticated enough to overcome his speech difficulties. The program could not recognize Joshua's speech for any word with an *er*, *ur*, or *ir* combination. Because speech recognition has improved it is suggested that speech recognition be considered again. During the summer, however, Joshua was fitted for braces and he had a difficult time adjusting his speech. He was resistant to training when he felt he could not say words correctly. In addition, the school did not have a quiet place for Joshua to access the program on a consistent basis. The team decides to wait to implement speech recogni-

tion until Joshua is more comfortable with his braces and can sustain his attention and take the time to learn the system.

Measures of Technology Effectiveness

When an IEP team recommends the use of technology, members should indicate how the use of the technology will be evaluated. In discussing quality indicators, the QIAT Consortium Leadership Team (Zabala et al., 2000), stressed objective measurement of changes. Using the QIAT quality indicators, Joshua's teachers may address specific areas in relationship to writing, such as:

- **Student preferences**. Joshua would choose to complete a writing assignment using word processing and word prediction.
- **Productivity**. Joshua would complete more writing assignments during a grading period.
- **Participation**. Joshua would take part in written activities in class and take word processed notes instead of receiving copies of notes.
- **Independence**. Joshua would complete a writing activity without any assistance.
- **Quantity**. Joshua would produce writing samples of increasing length.
- **Quality**. Joshua would produce writing samples that would be organized, include correct content, and be appropriate for the theme.
- **Speed**. Joshua would complete a writing activity faster than he would with paper and pencil.
- **Accuracy**. Joshua would produce writing samples with few or no errors in grammar, punctuation, and spelling.
- **Frequency**. Joshua would use word processing more frequently throughout the day.
- **Spontaneity**. Joshua would independently choose to use word processing and word prediction to complete any activity dealing with writing.

Teachers should be aware that not all indicators would improve with the use of assistive technology. Further, not all of these areas will improve at the same rate, therefore students and teachers may focus on one indicator at a time. Although the IEP team begins with the student and considers needs, current practice is to demonstrate how technology can increase student achievement. With the emphasis on access to general education and increased student achievement, the focus on the effectiveness of technology should include measures that consider academic goals.

What might Joshua's IEP team suggest? Team members first suggest that Joshua receive explicit instruction in the use of the technology tools paired with strategy training in written language. Then they hypothesize that his quality and his accuracy will improve with the use of technology tools. However, they also include goals and timelines for change. For example, the teachers look at quality and accuracy but not at quantity or speed. Previous studies have indicated that students need time to adjust to using the keyboard and word prediction programs; therefore, the first writing samples were frequently shorter and took longer to complete than paper-and-pencil products. Finally, teachers develop scoring guides to judge the quality of Joshua's writing and count the type and number of his mechanical errors.

Data should be kept about the frequency and spontaneity with which Joshua uses these tools. These measures would be related to his success in using the tools and the encouragement he receives for using them. For example, if he writes during class when he is bored then he will not be spontaneous in using a computer as he might get in trouble. If he creates problems in class when using a handheld to take notes then he will not want to use it. Or, if he is required to write everything on paper and make corrections before he is allowed to use the tools, he will not view these tools as aids to composition. In contrast, if he is supported in the use of word processing and word prediction, he might first increase his accuracy in spelling and grammar, thereby influencing his quality. With text-to-speech feedback, he might begin to notice grammatical errors and create longer sentences.

Eventually the team predicts that with increased use, Joshua's overall quantity and quality in composition will improve. This final result will have a direct impact on academic achievement.

Implications for Practice

When an IEP team recommends a technology tool, the team also should address implications for practice. Some general education teachers resist using assistive technology aids for students with mild disabilities because they are concerned that students will not learn to spell, use appropriate grammar, or develop good handwriting skills. In other words, they consider assistive technology to be a crutch. The research on using writing tools indicates that the technology does not automatically correct the problems. Students will still need to learn strategies for using the spell and grammar checks and receive explicit instruction in the actual academic skills (Gersten & Baker, 2001; MacArthur et al., 1995).

Teacher involvement, especially with strategy instruction for written language and the use of technology is critical for success (MacArthur et al., 1995; Wong, 2001). Students need explicit instruction in the writing process and must have a framework to guide their planning and revising skills (Gersten & Baker, 2001). Before teachers implement any technology-based program, they must understand the writing process, which includes planning, drafting, revising, and publishing. In addition, students also benefit from teacher-directed instruction in goal setting, brainstorming, and organizing (Troia & Graham, 2002). Finally teachers need to provide explicit instruction on the various aspects of word processing (e.g., spelling and grammar check, simple sentence editing) and word prediction programs.

Technology must be used throughout the process, not just for the publishing phase. For example, word processing can support editing and revision if students are taught how to edit as they write. Strategy instruction for the development and planning of writing might include prompting, outlining, and semantic webbing (MacArthur et al., 1995).

Conclusion

Although the effort may seem considerable at first, the results can be promising. Consider a recent entry in Joshua's journal. First he wrote a paragraph, and then he translated it using word prediction and word processing programs. Figure 5 provides a comparison of the results.

Success and independence provides students with their own motivation to continue to use the tools to support their lifelong learning.

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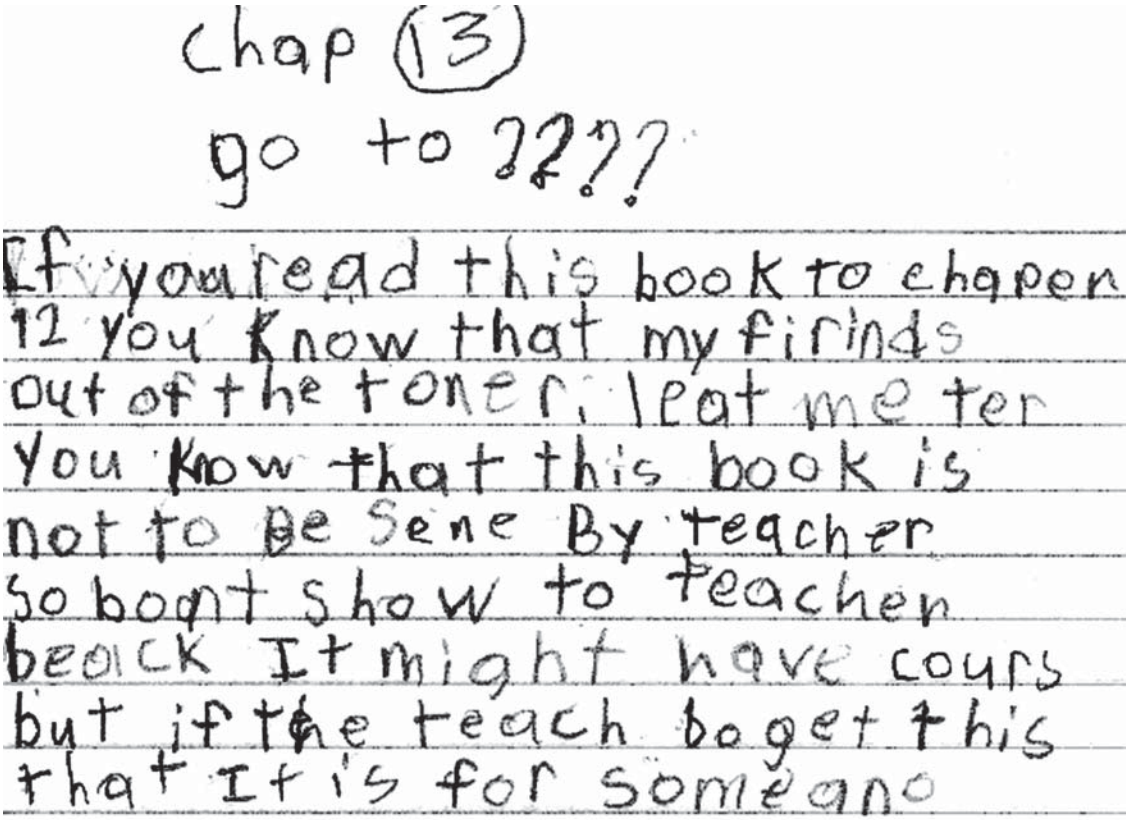
Figure 5: Free Writing in Journal



Retyped by Joshua using Microsoft Word and Co: Writer

Chapters 13 go to ????

If you have read up to this point you know that I and my friends and I got out of the hole. Let me tell you that if this book gets seen by the teachers don't tell that I wrote this book. It will have cursing in it. If the teachers get this book then I will get in trouble and so don't show it to anybody.

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