Developing Technology-Supported, Evidence-Based Writing Instruction for Adolescents with Significant Writing Disabilities

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Abstract: Writing is a recursive and complex set of cognitive processes that can be taught effectively to students with disabilities. Employing an adapted cognitive theory of writing, a broad view of what constitutes evidence, and the support of a variety of assistive and internet-based technologies, we developed a writing instructional program to meet the needs of novice adolescent writers with significant disabilities. In this paper, we share the principles and processes we engaged in to develop and implement a writing instructional program as well as how students responded to the program.

Keywords: Writing, Writing instruction, Internet, Evidence-based instruction

Writing is an essential academic, employment, and life skill. In academic settings, students use writing to learn a variety of subject matter, to communicate their understanding to teachers and classmates, and to express themselves. Adolescents and adults gain access to employment through letters of inquiry and introduction, and improve their effectiveness and status in the workplace by writing memoranda, directions, analyses, syntheses, and summaries. Throughout our lives, writing helps us establish and maintain social relationships, share experiences and feelings, record personal events and insights, and organize activities and events.

Writing is particularly important for students with disabilities because it enhances communication, increases independence, and makes a unique contribution to literacy learning. Students with disabilities who can write clearly have enormous access to the world through the Internet. Students with complex communication needs who can write clearly also can generate unique and precise face-to-face messages (Blackstone, 1989). Finally, while writing is one component of comprehensive literacy instruction, it is also essential in helping some students learn to read (Clay, 1998). Written message construction slows down the processing of letters, sounds, words, and texts and consequently allows students with disabilities to examine more carefully how print works.

Writing Challenges for Students with Disabilities

A variety of factors contribute to widespread writing difficulties for students with disabilities (see e.g., Sturm & Koppenhaver, 2000). Many students experience language delays or impairments, which contribute to struggles in producing written language. Physical or sensory impairments, and limited access to needed assistive technologies, restrict learning opportunities for others. Instruction focused on skill exercises with few composition opportunities, or low expectations of adults at home or school, slow progress. Still other students are taught by under-prepared professionals. For example, in Minnesota, current licensure standards do not require teachers of students with developmental cognitive disabilities to have

specific literacy methods coursework (Minnesota Administrative Rules, 2010).

In 2003, seeking to improve writing outcomes for adolescents with disabilities at a mid-western, mid-sized junior high school, a collaborative partnership between students in the Inclusion Program and preservice teachers at a nearby college was created and implemented. After discussing the types of students in their respective classes and the students' learning needs, the authors, a speech-language pathologist and a literacy professor, initiated an e-pal exchange, which required and promoted writing in a virtual social network. The writing program evolved and included evidence-based practices, and incorporation of a wide range of assistive and Internet-based technologies. In this seven-year case study, we discuss how and why (a) the program was designed, (b) a variety of assistive and Internet-based technologies were selected and integrated into classroom activities, (c) students were taught to use the technologies, and (d) students responded to the social-communication writing program.

A Theory of Writing

From the beginning, we sought a theory of writing to guide our instructional decision-making and technology selection for two main reasons: comprehensiveness and efficiency. Students served by the Inclusion Program were diverse in their needs and interests. We worried that in the absence of a guiding theory, we might waste valuable instructional time with generic instructional approaches or technologies, or worse, fail to provide needed instruction or supportive technologies.

After much consideration we selected the Flower and Hayes (1981) model of the cognitive processes underlying writing. We appreciated that it addressed writing as a complex interplay of thinking processes. This seemed in accord with our own observations of the difficulties that students with disabilities experienced in planning and organizing their ideas, and in expressing them coherently. More important, however, research suggested that the model was quite accurate, explaining approximately 87 percent of the variance in student writing quality (Breetvelt, van den Bergh, & Rijlaarsdam, 1994). We respected the model, because it had been derived by the authors from empirical evidence as they carefully studied transcripts of real writers thinking aloud in the act of composing. Finally, we determined that this theory was widely respected in the writing community, having been cited more than 1,400 times to date [and more than 2,500 times if we included the companion Hayes and Flower (1980) article] according to a readily available search engine, *Google Scholar*.

Flower and Hayes (1981) propose that the constructs necessary to written communication include planning, translating, and reviewing. *Planning* involves setting goals, formulating ideas, and organizing thoughts. Planning addresses questions of why we want to write any given text and what we want to share. *Translating* is the process of converting nonlinear and overlapping experiences and ideas (e.g., sensory images, feelings, or impressions) into linear, written language using print conventions. *Reviewing* requires both revising (i.e., examining, ordering, and reordering texts to best effect) and evaluating the text according to the author's plan.

Modifications to the Original Theory.

We combined elements of two other theories with Flower and Hayes (1981), because they helped us better consider the complex writing challenges of students with disabilities. First, we added a construct called production. Production describes the process of using a pencil, or an alternative writing tool, to put words on paper, or an alternative technology such as a computer monitor, in visible or

tactile form. We recognized that many students with disabilities have to attend to the use of their pencil more consciously and specifically than typically-developing students who have mastered pencil use or touch-typing. Students with physical, cognitive, or sensory disabilities must always direct substantial attention to the use of their writing implements (Koppenhaver, Pierce, Steelman, & Yoder, 1994).

Next, drawing on the work of van Kraayenoord, Moni, Jobling, Koppenhaver, and Elkins (2004), we added two contextual factors to the original model: motivation and social context. Motivation affects the writer's willingness to actively engage the writing processes individually or together, while the social context impacts motivation and the rest of the writing model. We believed, initially, that these two contexts might be most dramatically changed through the use of our fledgling e-pal plans and incorporation of assistive technologies.

We considered the resulting model an example of situated cognition (Gee, 2001), and we pictured it in our minds and practice as seen in Figure 1. That is, the model portrayed for us the nature of writing in classrooms serving children with disabilities. It enabled us to act on our belief that all students can learn to write by helping us more systematically consider what we might need to provide, support, or modify in order to improve student writing experiences and outcomes. It also allowed us to consider which technologies we might employ to best address which specific student needs. Finally, it made it possible for us to explore what we

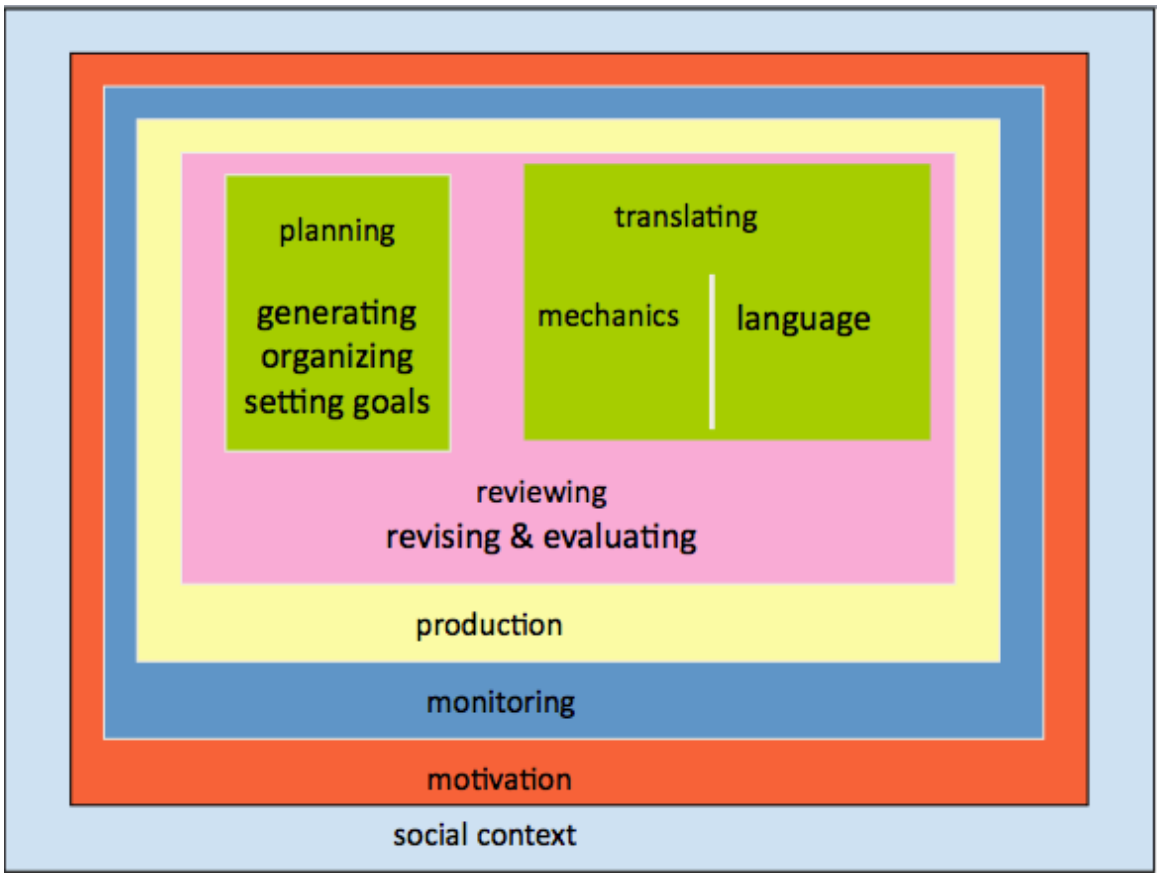

Figure 1. A situated cognitive model of writing.

needed to learn next in order to more effectively assist student learning.

Believing that the cognitive constructs of writing are similar across individuals with and without disabilities (see e.g., Sturm & Koppenhaver, 2000), we began to explore the literature on both typically developing children and children with disabilities. What we have concluded from that research in the years since is described next.

Typically-Developing and Low-Achieving Writers

We were able to identify two large-scale meta-analyses by Hillocks (1984) and Graham and Perin (2007). Hillocks' meta-analysis included 60 studies conducted between 1963 and 1982 and 75 experimental treatments of writing instruction with students in elementary and secondary school. The most effective instructional mode, what Hillocks described as the environmental mode, involved activities with clear and specific objectives, engagement of students with one another in a particular aspect of writing (e.g., planning), and high levels of student interaction with one another about those activities. In examining Hillocks's instructional focus, five instructional strategies demonstrated positive effects on achievement: inquiry, rubrics, sentence combining, the use of writing models, and free writing.

Graham and Perin (2007), in the most thorough and comprehensive review to date, identified 123 studies since the 1960s and 154 experimental treatments of writing instruction involving students in grades 4-12. Like Hillocks (1984), these authors reported that effective instructional strategies included inquiry, sentence combining, rubrics, and the use of models. The authors also reported that the most effective instructional strategies explicitly taught students planning, translation, and revision strategies, as well as how to write summaries. In addition, scaffolding strategies with positive effects included prewriting activities, peer assistance, and process writing approaches. Word processing also improved student-writing quality.

Student Writers with Significant Disabilities

Our literature searches involving students with significant disabilities did not yield similarly detailed results. What we discovered was that much more research had focused on reading than on writing, was descriptive rather than experimental, and focused on skills instruction disconnected from larger writing interventions. At the same time, however, we found little to suggest any real differences in what is effective.

Research on students with autism spectrum disorders (ASD), for example, suggested the effectiveness of a variety of practices documented by Hillocks (1984) and Graham and Perin (2007) with typically developing students. Rousseau, Krantz, Poulson, Kitson, and McClannahan (1994) demonstrated that a sentence-combining strategy led to writing quality gains for three students with autism spectrum disorders and moderate intellectual disabilities. Colasent and Griffith (1998) found that drawing and retelling the meaning of stories orally and in writing (i.e., a summarization strategy), led to improved writing for three young adolescents with ASD and moderate intellectual disabilities. Bedrosian, Lasker, Speidel and Politsch (2003) conducted a comprehensive (and successful) intervention involving an adolescent with ASD and strategies documented as effective in typically developing students. These included (a) peer assistance, (b) process writing, (c) use of a story map strategy, and (d) explicit instruction.

Similarly, we could find little on students with significant disabilities. Kliewer and Biklen (2001) related the case of Kimberly, a student

with visual impairments and severe intellectual disabilities. Peer assistance in an inclusive classroom, and use of captioned photos from home, assisted Kimberly in writing with increasing quality and independence across a school year. Blischak (1995) documented the case of Thomas, a nine-year-old child with multiple disabilities. His team provided him with adapted and inclusive literacy experiences leading to his growth in reading and writing through second grade. These experiences included the use of tactile books, enlarged print, communication symbols to request books and print experiences, alphabet access on his communication device, and encouragement to engage in invented spelling. Koppenhaver, Evans, and Yoder (1991) concluded that literate adults with severe physical and communication impairments had attended schools that provided them much of what is known about best practice in typically developing students.

A review by Erickson, Hanser, Hatch, and Sanders (2009) identified no studies of writing instruction for students with significant intellectual disabilities. However, in examining research on students with mild intellectual disabilities, the authors reported that the research supported two approaches found effective for typically developing students: writing strategy instruction (Graham & Perin, 2007) and student collaboration (Graham & Perin; Hillocks, 1984).

New Literacies

As if learning to read and write text weren't sufficiently complex, an explosion of technologies (e.g., laptops, netbooks, hand-held devices, and e-text readers), increased access to the Internet, and Web 2.0 applications (e.g., (micro-)blogs, wikis, and social networking sites) have dramatically impacted the ways that people use text in social contexts. As e-mail has supplanted letter-writing and texting has become the preferred teen communication mode (Lenhart, 2010), being able to read and write conventional text is now insufficient. To socially engage with peers and young adults, students must be able to navigate, comprehend, analyze, synthesize, and construct digital texts and multimedia on the World Wide Web (Leu & Kinzer, 2000).

Leu (1997) was one of the first scholars to perceive a particular challenge of these new literacies: their deictic nature. Linguists describe deictic words as those whose meaning is dependent either on the time or space in which they are spoken or the perspective of the speaker. For example, *tomorrow*, *today*, or *yesterday* might be any day of the week depending on when they are spoken. *I* and *you* are not the same meaning if I speak them or you speak them, and *here* may be *there* to me if it is *here* to you. Deictic terms are difficult for developing language learners because their particular meaning is always dependent on something or someone else. Leu argues that new literacies also are deictic because (a) we continually reshape our definition of literacy based on new technologies; and (b) every text on the Internet can ultimately be connected to and, consequently defined by, every other. The meaning of hypertexts, such as those found on the Internet, depends as much on readers and which hyperlinks they choose to follow as it does on the original author's intent. Teachers who apply new technologies in their classrooms do more than motivate their students--they prepare them for a technologically-infused world.

We were particularly interested in Stanford & Siders's (2001) study that found e-pal exchanges led to greater gains than a pen pal partnership between preservice teachers and students with and without learning disabilities. Given evidence that struggling writers (Allington, 2006), students with learning disabilities (Leinhardt, Zigmond, & Cooley,

1984), and typically developing students (Graham & Perin, 2007) improve the quality of their writing when they increase the quantity of their writing, it was interesting to us to see how relatively simple it might be to effect positive change.

Literacy Program Beginnings

Armed with a theory of writing and evidence of what works, we initiated the technology-supported literacy program. The e-pal program seemed to be a practical way to motivate adolescents, increase writing quantity, and begin to explore new literacies for inclusion students (and their teachers). The collaboration was initiated between the students in the Inclusion Program and preservice teachers. This collaborative project has evolved over the past seven years, but the e-pal component has remained at the heart of the program.

Participants, Structure, and Protections

Students in the Inclusion Program (see Table 1) were identified as having moderate to severe intellectual disabilities, autism spectrum disorders, physical impairments, or other health impairments. Most came to seventh grade with limited reading skills. For many, literacy instruction had been restricted to sight

Table 1
E-Pal Participant Characteristics

Junior High Students (*N*=110 7th and 8th students)	Preservice Teachers (*N*=240 undergraduate students)
88 had significant disabilities including autism, intellectual disabilities, physical impairments, or other health impairments and were eligible to take the modified state reading test; all read from below pre-primer to the 2nd grade level and had limited or no writing experience.	Enrolled in introductory reading methods courses for elementary preservice teachers, inclusive education methods, or introductory reading methods courses for preservice special education teachers.
22 had learning disabilities, emotional/behavioral disorders, physical impairments or hearing impairments; 20 read at or below the second grade level; 2 read at the 5th grade level but experienced pragmatic and written language difficulties; and had beginning writing skills.	Participation was a course requirement accounting for 10% of final course grade.
95 students received speech and language services.	
E-mail communication and blogging comments were composed during speech/language therapy sessions or during special education literacy classes.	E-mail communication and blogging comments were composed as an ongoing homework assignment throughout the semester.

word instruction, copying and handwriting exercises, and grammar worksheets. As a consequence of their learning difficulties and these instructional activities disconnected from either their needs or evidenced-based instruction, most of them had negative attitudes about reading and writing. The students received specialized instruction for reading and math but participated fully in regular education health, social studies, and science classes. Students participated in the e-pal program for up to two years.

College student e-pals (see Table 1) initially were undergraduate teacher education students enrolled in an inclusive education methods course at a mid-western college. In subsequent semesters we involved undergraduates enrolled in an introductory reading methods course at a second university. We envisioned the e-pal program as an ideal opportunity for undergraduate students to gain experience with students with disabilities while increasing understanding of their learning difficulties and technologies to support their learning. Undergraduates were told to: (a) get to know your e-pals through writing; (b) provide good language models by writing at the level of your e-pals; (c) respond to e-mails within 24 hours of receipt; (d) click reply to respond to your e-pals, so that their message is included with yours to provide a context for any needed teacher assistance; and (e) send blind copies of the e-mails to both authors, so that either e-pal partner could be supported as necessary. Undergraduates participating in the program changed with each new semester.

Parents of the junior high students were notified about the project and told that teachers would be monitoring the e-mails. Parents were informed that all e-mails would be printed out and sent home for additional reading practice. Initially the school e-mail system was used, but eventually we switched to *Gaggle* (http://www.gaggle.net), which offered a free e-mail program for schools. Today *Gaggle* supports additional message board and blog capabilities. The advantages of *Gaggle* e-mail were many but included first author control of all student e-mail to monitor the frequency and content of writing; *Gaggle* blocking of questionable language through administrator controls; and speech support within the program that could be used when reading or writing e-mails.

Writing Structure

The junior high school students were taught a writing structure that included beginning each e-mail with a greeting, answering their e-pal's questions, asking a new question, and concluding with a signature. This format supported not only the planning process (Flower & Hayes, 1981) but also the pragmatic rules of social communication: (a) knowing to answer when a question has been asked; (b) being able to participate in a conversation by taking turns; (c) being aware of the need to introduce a topic of conversation in order to support listener understanding; (d) knowing which words or sentence types to use when initiating a conversation or response; and (e) maintaining or changing a topic appropriately (Bowen, 2001).

Students were taught pragmatics by comparing an e-mail to an e-pal with a conversation. A greeting such as "Hi Linda," would be appropriate to initiate a conversation or an e-mail. Students were taught that the next part of the e-mail should consist of answering the college e-pals' questions or commenting about what the e-pals had written. It was explained that, as in a conversation, topic maintenance is important. After answering their e-pals' questions, the junior high students were instructed to ask a new question related to the same topic or to initiate a new topic, as would be appropriate in a face-to-face conversation. Termination of

a conversation or e-mail was the final step and consisted of closings such as, "Your friend" followed by the junior high student's name.

Prior to launching the e-pal program, the first author found that some of the student spellings consisted of drawings and random letters that demonstrated little apparent awareness of sound-letter correspondences within words. Most of the students were able to spell the beginning and ending sounds of most words logically. All of the students found translation extremely difficult; they simply could not spell the words they wanted to write. To provide a successful, motivating, and independent writing experience, students were taught to use *Co:Writer®,* now in version 6.0 (Don Johnston, Inc., 2010). *Co:Writer®* is an intelligent word prediction program that provides spelling, grammar, and speech support. One language/literacy group session of 30 minutes was devoted to this instruction at the beginning of each school year. Since nearly all of the junior high students participated in the project for two years, this was a refresher for most of the eighth graders. An LCD projector was connected to the computer and *Gaggle* e-mail opened up. After the speech-language pathologist discussed and modeled the use of *Co:Writer®* in *Gaggle*, a wireless keyboard was passed from student to student. The group would dictate a sentence as each student practiced using *Co:Writer®* with the wireless keyboard.

Initially a paraprofessional, a special education teacher, or the speech-language pathologist (SLP) monitored each student's use of *Co:Writer®*. Custom dictionaries were created in *Co:Writer®* with words such as the school's name and the e-pal's name, so that those words readily appeared in the prediction screens. Attention was paid to the words each student wrote so that frequently-used words could be added to that student's custom dictionary. The 'learn new vocabulary feature' was turned off, so that misspelled words weren't added to the predictions. In most cases, *Co:Writer®* was able to predict the word the student wanted to write, even if the student only knew the initial letter of a word.

Approximately 80% of the students learned to use *Co:Writer®* independently within six class sessions of the initial demonstration and guided practice. If students needed additional support, they were encouraged to seek peer assistance. If students had questions after that, they were instructed to ask the teacher or a paraprofessional. One student, an adolescent with autism, did not require the software because of her excellent spelling skills.

The remaining 20% of the students had greater difficulties learning to use *Co:Writer®* for two different reasons. Although their texts contained numerous spelling errors, half of these students had conventional spelling skills and were accustomed to composing text on a word processor. While the software supported correct spelling, the students felt that using the program slowed their composing process too much. The remaining students who struggled were those who had never composed text and often sought to copy text rather than compose e-mail messages. To teach them that writing involved composing their own ideas, they were introduced to *Clicker 4*, now in version 5.0 (Crick Software, 2011). Then, as soon as they grasped that concept, they were transitioned to *Co:Writer®*. See Appendix A for a description of the training provided in using these and other software.

One student came to seventh grade knowing just 13 alphabet letters. He had good expressive language skills but no sound-to-letter correspondence. He was taught to dictate what he wanted to write. With knowledge of his intended message, the SLP would then prompt him in the following ways, "Say the first word in your head. What does *hi* start with?" During the first few weeks, the

student would propose random letters, and the SLP would then tell which letter to try. Because of the use of custom dictionaries and the quality of prediction in *Co:Writer*®, the student was able to use the speech support in the prediction windows to locate the word he wanted to spell. By the end of eighth grade, this student was able to determine the first letter of the word he sought, find that letter on the keyboard, and write more independently.

Paraprofessionals helped students learn to use the e-mail structure, prompting them as needed at each step of the process. Staff members were instructed not to correct spelling or grammar but rather to encourage student independence by responding, "Say it in your head and type the way you think the word is spelled." The prediction in *Co:Writer*® was so accurate that the students' target word usually appeared. Students quickly learned to click in the prediction screen in order to hear words they could not read. One of the better spellers in the group made the comment that seeing words spelled correctly in *Co:Writer*® helped him spell them more accurately even when he used pencil and paper. Research with developing writers suggested that if we were consistent in this encouragement, students would attempt to write longer texts with more varied word choice, take greater ownership of their writing, and skills would improve over time because of the use of a real audience and *Co:Writer*® (Clarke, 1988; Williams, 2002).

To further increase not only student independence but also improve writing quality, students were asked to read what they had written and to have the computer read aloud their texts using the speech feature of *Gaggle* e-mail. Students were always given the option of revising, editing, or sending e-mails as written. In this way, both our instructional guidance and the *Gaggle* technology supported translation but also provided increased opportunity for review and evaluation--not skills our students, or most beginning writers, tended to engage in without prompting.

E-pal relationships were concluded at the end of each college semester, and new partnerships began with the next. By the second semester, the first author had created a rubric addressing e-mail format, spellchecking, and e-mail review. The rubric, essentially a checklist of questions about each step of the e-mail writing process, asked students to mark off each item as they completed it (see Figure 2).

The rubric, another evidence-based strategy (Graham & Perin, 2007; Hillocks, 1984), was given to staff to remind them what they might need to prompt as students composed, and to students to encourage them to monitor their writing.

By referencing our writing model (see Figure 1), we were better able to understand why the project seemed so successful for the junior high school students with significant disabilities. Planning was supported by the e-mail text structure (see Figure 1 for an example). Spelling difficulties (i.e., translation) were supported with *Co:Writer*®. Revising was encouraged by the rubric and supported by rereading and listening to the e-mails in *Gaggle* before sending. Motivation could not have been higher because of student independence, authentic writing, and student success. Students eagerly sat down to write their college e-pals and waited impatiently for responses, checking and rechecking their e-mail accounts. Evidence-based practices included the use of writing models, prewriting as e-pal messages were reviewed, strategy instruction (e.g., use of speech feedback to review messages or use of *Co:Writer*® to improve spelling), rubrics, and use of a word processor (Graham & Perin, 2007).

Have you:	
	read the latest e-mail from your e-pal?
	selected "reply"?
	written a greeting?
	answered your e-pal's questions?
	asked your e-pal a new question?
	included a closing or good-bye?
	used the spellchecker and corrected misspelled words?
	read the e-mail to yourself?
	read the e-mail using *Gaggle* speech support?
	revised the e-mail if it didn't sound right or make sense?
	sent the e-mail?

Figure 2. E-Mail Rubric

Virtual Authors Blog

In 2006, with the teachers and students now feeling confident about e-pal writing, the Virtual Authors Blog (http://www.hpjh.blogspot.com) was created. The blog provided students with additional authentic and motivating opportunities to read and write, and it provided the preservice teachers with an additional way to observe the interests and abilities of their e-pals. Each week the SLP and the students posted an entry, and then the students commented online in response to the entry. Parents, teachers, and college e-pals were also encouraged to comment online in order to provide good writing models and more authentic reading opportunities for students.

Many students in the Inclusion Program had language difficulties, specifically in asking and answering 'wh' questions, so these types of questions were posted regularly in the blog entries. Questions reflected a variety of student interests including (a) current events (What will you do on Halloween?); (b) school curricula (What is your favorite fact about the sun? Why?); (c) comparisons (What do you like best about where you live?); and (d) popular culture (Who is your favorite baseball player? Why?) .

The ability to ask and answer questions was something the e-pal text structure supported through practice. By adding the questions each week to the blog and discussing them with students in mini-lessons, three evidence-based practices were incorporated: models,

peer assistance, and explicit instruction (Graham & Perin, 2007; Hillocks, 1984). Additionally, a sentence transformation model was included in blog posts for students who had difficulty answering questions. For example, for the questions, "What is your favorite food? Why?" the response structure, "My favorite food is …, because…" was included. This employed two evidence-based strategies, the use of a written model and a prewriting scaffold (Graham & Perin; Hillocks).

Deeper Into New Literacies

As e-pal interactions and blog writing continued to develop among students, we continued to explore additional supports. One clear challenge was the students' relatively limited understanding of the world; they could not write about what they did not know. The students' had limited background knowledge due to a variety of challenges, including limited social studies and science instruction prior to entering the Inclusion Program, learning difficulties and disabilities, living in homes of poverty, and learning English as a second language.

One of the ways we began to build background knowledge was by embedding slideshows on various topics into the Virtual Authors Blog. Slide (http://www.slide.com), *Flixtime* (http://flixtime.com), and *Animoto* (http://www.animoto.com) provided a variety of easy-to-use features for creating slideshows from photos or video, adding text and music, and including different options to increase student engagement in the material. *Flicker* (http://www.flickr.com/) images were used to avoid copyright issues. Some of the slideshows were created during a language and literacy group either to support activities in that class or in the students' regular education classes.

Students took turns helping to create blog questions and posts. On one occasion, a student verbally generated questions for the blog, "What do you like best about fall? Why?" He then searched the public domain photos in *Flickr's* creative commons (http://www.flickr.com/creativecommons/) for related pictures. The SLP assisted him in transferring the photos into an online slideshow (http://tinyurl.com/3pzfb28) that provided all of the students with background knowledge that helped them decide how to respond to the questions.

For a posting on favorite African American heroes, students each chose their own book. A computer was attached to an LCD projector, and students took turns discussing and selecting pictures to write about from those downloaded earlier by the first author. They shared a wireless keyboard, used *Co:Writer*®, and assisted one another in summarizing important information about the heroes.

This instructional activity provided the widest variety of instructional supports of any implemented to that point in the writing program, addressing every aspect of the model we had developed. Working from the outside in (see Figure 1), this activity continued building the classroom writing community, which created an appropriate social context for learning without fear of embarrassment or failure. Motivation and engagement were increased because students were given choice and each became the classroom expert on an individual hero. Monitoring took place as the group assisted one another in determining what and how to communicate about each hero. Text production was facilitated through use of the shared wireless keyboard. Planning was accomplished through student reading about each hero prior to the writing activity. Translation was supported not only through *Co:Writer*® but also through peer suggestions.

Evidence-based practices included peer assistance and mini-lessons on summarization (Graham & Perin, 2007).

Summarization was taught by the SLP through think-alouds: "I want to summarize what we just read. I'm thinking that the most important things about what we read were…" The group practiced '50-cent summaries.' Each word *cost* five cents, so the group would have to summarize the targeted text in 10 words or less. Suggestions would be written on the board, and then edited by the group, making sure that the resulting summary not only cost 50 cents or less but also was an accurate reflection of the important ideas in the text. Students were highly motivated to stay within their budget.

Voicethread (http://voicethread.com), a web-based technology offered free to educators, was used extensively in the Virtual Authors Blog. *Voicethread* allows users to create multimedia texts and obtain direct feedback from the audience. One favorite of both the junior high school students and the university e-pals was *The Important Book* (http://voicethread.com/?#u7667.b456443.i2427489). Based on Margaret Wise Brown's (1949) original children's book, this patterned text describes a variety of familiar objects and ideas by listing attributes and uses. Students used the text structure to write about their e-pals. Next they arranged the images and text in *PowerPoint*™, which was uploaded to *Voicethread*. Finally, students recorded themselves reading their individual pages. Students were highly motivated to produce an excellent recording for their e-pals, often practicing rereading their pages. The college e-pals were so impressed with their junior high e-pals' creation that they replied with their own (https://voicethread.com/?#u8135.b469272.i2495958) and gained firsthand experience with new literacies.

Microblogging with Twitter

Students were set up with *Twitter* accounts (http://www.twitter.com) as another motivating and authentic writing opportunity. Because tweets are limited to 140 characters, beginning writers did not find the task overwhelming. All but two students liked this idea and requested *Twitter* accounts. Students and teachers followed each other's tweets, and preferences were set so that outsiders had to be invited in order to follow a student. Students attached *Co:Writer*® to their tweets to continue to support their spelling. They also chose to follow groups like the Jonas Brothers and the local professional hockey team, thereby increasing their reading volume. With *Twitter*, students were now choosing to read and write even more, including during free time!

Students also learned important lessons about the public nature of the Internet (e.g., do not post what you do not want everyone to know). One male student regretted posting that he liked another female student. He learned a lesson just like anyone else who has posted questionable content on sites like Facebook only to suffer repercussions from family or employers.

Instant Messaging

On several occasions collaborative groups of junior high students had instant message conversations with the university students. For the junior high students, *Co:Writer*® was attached to the instant message system, and students were able to help each other compose messages. On one occasion, the university students wrote, "Cheer for our basketball team. They made the Final Four." The junior high students responded, "Who cares about basketball? Cheer for our hockey team who made the Frozen Four." The college students messaged, "Who cares about hockey?" By this time the junior high students

were laughing so hard they had difficulty typing. They finally wrote, "Okay, we'll cheer for your team if you cheer for ours."

Student writing quality and other language skills improved over time. With the use of assistive or web technologies, as well as instructional strategies, students wrote more independently. By the time they left Highland Park Junior High, they understood how to convey their own thoughts.

Outcomes and Benefits

The instructional program described in this paper is not a formal research study. It is instead a description of the use of a theory of writing to guide instructional planning and program development as well as careful technology selection in the support of student writing growth. Consequently, no formal quantitative or qualitative analyses were drawn upon in describing the program's outcomes and benefits. Rather, we drew informal conclusions that rely upon informal teacher observations, teacher notes on interactions with participants, notes from conversations with parents and staff, emails exchanged between the authors, and the students' e-mails, blog comments, and other multimedia compositions. We present the following summary of these informal observations tentatively, relying upon other scholars to explore the effectiveness of such an instructional approach ultimately with more rigorous research designs.

The benefits of this evidence-based writing program divided primarily into two categories: (a) increased student motivation, and (b) growth in written communication skills. Students were motivated by writing for real audiences in valued social contexts supported by technology. As they learned to use a variety of assistive and web-based technologies, and engaged in interactive literacy learning opportunities, their skill and independence in written composition also grew. They readily assisted one another and engaged in every aspect of the writing process from planning to composing to revising and editing. We address these two areas of student outcomes below.

Student Outcomes: Increased Motivation

Each semester, one of the questions on the blog asked students how they felt about having an e-pal. Across the seven years, all but two of the 110 students reported that they enjoyed the experience. The other two rated the experience as "okay," but noted that they preferred writing their e-pals to other school assignments. More than one student wrote comments such as, "I like having pen pals because it is fun talking about sports," "a pen pal is a friend you can talk to if you are sad or happy," "you are my best friend," and "when I don't feel like playing with my brother, I can write to my pen pal."

Experienced student participants understood that their e-pal relationship ended at the conclusion of each semester and were eager to meet their new e-pals at the start of the next semester. When inevitable start-up delays were encountered each semester, the growing question from junior high students was reiterated, "How much longer until we get new pen pals?"

Occasionally, e-pal friendships lasted longer than a single semester. Tatyana, for example, was a university foreign exchange student from Russia who wrote in her final e-mail to Latrese, "I don't know where in the world I'll be next year, but wherever that is, I'll write to you." Latrese, a reluctant and struggling writer prior to the e-pal experience, and Tatyana sustained their e-mail friendship for another three semesters, until Latrese completed eighth grade and moved on to high school.

Even for e-pal partnerships fitting the more usual single semester exchange, junior high students did not see e-mailing, blogging, or tweeting as academic tasks so much as social activities. Most checked their e-mail repeatedly throughout the day. Most students viewed their e-pal partners as friends and confidantes. They wrote about birthdays, sports, music, television shows, and boredom. They sought them out for advice in dealing with school and personal problems.

This personal correspondence often changed student views about the writing process and themselves as writers. For example, two students, who initially reported that they "hated writing," changed their responses to "love writing" after their first semester in the program. Although neither student had access to computers at home, both started writing regularly in the evenings and on weekends with paper and pencil. Another student decided that she wanted to become a "famous writer." On more than one occasion she wrote stories and sent them to the second author. This same student requested a portable word wall for her home to assist her writing.

University e-pals found the program motivating as well. In course evaluations and reflections, they typically reported that they were moved by the sincerity of their e-pals, intrigued by the technologies that the students used, and surprised that friendships could grow through e-mail in such a short time span. Students were often disappointed that their e-pal had not written them as frequently as a fellow student, but when the first author shared background information at the end of each semester about the students' home life, disabilities, and learning needs, the disappointment usually disappeared. Comments like Nathan's were representative of the tone and feelings of most of the university participants. Nathan wrote at the conclusion of the semester, "I enjoy learning things that will help me in my future teaching. I love talking to my e-buddy because he is awesome. Hank is the man and I feel like I have made a lifelong friend. I hope to stay in contact with him even after this year is over. Hank, if you read this buddy, you are the coolest kid ever!"

Sometimes there was a mismatch in the number of e-pals at each site, so one student or the other might have two e-pals. Leslie, a student preparing to become a speech-language pathologist, wrote,

> I love having two e-pals! John and Daryn are great fun to e-mail back and forth with. It has been really nice getting to know them. Thank you for this opportunity. It has been a great learning experience, besides gaining two new friends.

She continued writing after her semester concluded until the end of the school year even though she was packing for a cross-country move.

The writing program motivated students to such an extent that they did not view the writing as schoolwork and sought it out even when it was not required. Perhaps the greatest testament to the motivating influences of the program occurred when a typically developing student in regular education approached the first author and asked with great sincerity if he could sign up for speech, so that he could "get one of those college e-pals."

Student Outcomes: Written Communication Growth.

With the support of assistive technology, all students exiting the Inclusion Program after eighth grade have achieved the ability to write connected text independently. Initially, some students would regularly seek and request "something to copy" during writing time. By eighth grade, however, they understood that

writing was about conveying one's own thoughts on paper. Teachers in the regular education classes noted how students were both more eager and more capable in class writing tasks.

The growth in written communication of several students is described below, beginning with John. He, like many students with a diagnosis of autism, had great difficulties in processing oral language. As an entering seventh grader he demonstrated knowledge of about 20 sight words but was unable to read connected text at even a pre-primer level with understanding. He readily copied text but was unable to write generative text. He found 'wh' questions difficult to understand, particularly questions beginning with "why." When the e-pal and blogging project were explained to John's mother, and the emphasis on 'wh' questions overviewed, she expressed serious doubts about his ability to manage. She felt that having an e-pal and responding to questions would simply be too abstract for him to understand.

Assistance was provided to John to get started writing by introducing him to *Clicker*, a picture-supported word processor. This helped him transition from copying to composing. As soon as John began to understand that writing was generating his own thoughts, the first author replaced *Clicker* with *Co:Writer®*. John quickly learned how to use the speech feedback feature to assist him in composing words he could not spell.

During his first semester he typically wrote short, heavily-prompted responses to his e-mail partner. For example, on one occasion the SLP began by asking, "What greeting do you want to use?" John said, "Hi." That prompt was enough for John to type an 'h' and then find "hi" among the predictions in *Co:Writer®*. Next he was told, "You need to write the name of your e-pal." John attempted to spell "Angela." A similar process was used for the remainder of the email, with verbal prompting to get John to answer his e-pal's questions, ask a new question, and end with a closing. Here's the message that resulted:

> Hi angala. How are you. I am great. I like this movie. Stup up 2. my favorite color is blue. My favorite almalls is cow. My favorite to sprots. Is football. What to do this weekend. Your friend john.

Initially the SLP had to prompt John word-by-word in order to get him to write a sentence. Verbal prompting was employed with John because he tried to copy written text rather than compose messages. Two years later, his familiarity with the e-mail structure and basic sentence structures with Co:Writer® support allowed him to independently write messages like the following:

> Hi lindsay how are you. I am great. What favorite is house. I went to see a meeting jay and lizard. I want to see a steve blues and mailboxs. What do this weekend. I went to see a rides a mat eddie birthday partys. I went to see a pop and food to drink. I went to see a mats friend. I went to see a grandpa grandma. I went to see a appiebees. Talk to you later. John.

His e-mails had roughly doubled in length, from 30-40 words to 80-90, as had his sentence length (from three to four words to six). He was comfortable expressing feelings and describing actions. His vocabulary, spelling, and ability to communicate were growing. What his mother valued as much as John's growth in his written communication was his increased ability to communicate face-to-face and understand 'wh' questions. This became most evident in the spring of his 8th grade year when he became upset. When his mother asked, "Why were you so upset," he

replied, "Because April (his paraprofessional) was not there." John had learned the meaning of 'wh' questions and used that understanding to communicate his feelings.

Chuck, another student with a diagnosis of autism, had difficulties understanding and expressing language when he entered the program. In seventh grade, upon entry into the program, he wrote sentences like "pen pal is like send your friends and your message" and "my most annoying insects is gnat because they suck blood like others of insects." Written language seemed to help Chuck better understand both written and oral language. He seemed to benefit especially from instruction in the use of sentence frames and sentence combining (Graham & Perin, 2007; Hillocks, 1984). For example, in response to instruction in the use of one early sentence frame, "My favorite food is…because…," Chuck wrote, "My favorite food is double cheeseburger because it taste juicy." By eighth grade, Chuck wrote sentences like, "The most important thing about my e-pal, Kaitlyne, is that she is charming. She is a good friend and she is a football fan." Both his writing and his speech demonstrated improved sentence structure and complexity.

Davey, a young man with Down syndrome and complex communication needs, was approximately 40% intelligible to familiar listeners. At the beginning of seventh grade, he could read some sight words but his only writing was copying. On an informal reading inventory he placed at the pre-primer level on word identification but was unable to reach criterion at that level in reading or listening comprehension tasks. When spelling unknown single-syllable words, Davey could represent initial and final sounds logically.

Davey especially benefited from the level playing field created by e-mail communication and the e-pal project structure. The semester he began participating in the project, his college e-pal did not know that Davey had significant communication problems. He also had no idea that Davey was a reluctant oral communicator because of his communication impairments. He was unaware that it may have taken Danny up to 30 minutes to compose a four-sentence e-mail. Like John, Davey was transitioned from copier to a composer by using *Clicker*.

As he became a writer, Davey revealed his love for humor and would always include a joke at the end of his e-mail. His college counterpart would reciprocate. Davey's mother reported that the printed e-mails were the first thing out of Davey's backpack, and that he would read them to his family. Davey's mother also reported her surprise when Danny went to a movie with a friend and then independently composed a thank you note to the friend.

By his second year in the project, Davey's transformation as a writer was remarkable. He was using Co:Writer® to independently compose e-mails like the following:

> Hola Barbara, My favorite subject is math. I really like baseball. I like playing with my dog Buster. Do you have any pets? What did the hot dog say when it won the race? I'm the wiener! Adios Davy

Another student, Jason, had a rare neurological condition and knew just 13 letters of the alphabet when he arrived in seventh grade. He was unable to identify letter-sound correspondences. A custom dictionary was created for him in *Co:Writer®*, and he was taught how to use the spelling prediction. Initially he could not even produce a logical first letter, so his teachers would tell him the first letter. By using the speech support in *Co:Writer®*, he then found the word he wanted. By eighth grade he developed the

ability to logically predict the initial letters of words he wanted to write and was able to write independently with the support of this software.

General Outcomes and Benefits

Beyond student growth in motivation and written communication, this program offers a variety of more general contributions to the assistive technology outcomes literature. The program model points to the value of research and practice integration. In this particular case, the integration led to the identification of a writing theory and the selection of evidence-based practices to address components of the model and more specifically target student needs. Research did not just inform instruction; it unified program design and implementation.

In addition, the instructional design bridged the needs of students in a university preservice teaching program and a junior high school inclusion program. This particular model enabled students with disabilities to effectively address their learning needs by engaging in purposeful social interactions via technology-supported written language use. It also enabled university students to better understand the interests and learning needs of diverse, beginning writers with a wide range of disabilities. Every e-mail interaction and blog posting provided a virtual practicum experience for preservice teachers on the value of real audiences, the range of literacy- and student-centered applications of assistive technology, the power of engaged learning, and the nature of diverse learners. The instructional design enacted one of the strengths of the Internet, the ability to offer cost-effective and efficient virtual experiences that dramatically enrich the learning opportunities of both diverse learners and preservice teachers.

Finally, the instructional design enabled us to become more intentional and thoughtful educators. The theoretical framework guided our thinking about student needs, instructional strategies, and the selection and use of assistive technologies. We read and discussed both the theoretical model and research on best practice in written language intervention. We suggested readings to one another, searched the Internet for technologies to address particular aspects of the model, and frequently discussed a wide range of instructional issues via *Skype*™ (http://www.skype.com) and email. Theory became the road map to our planning, professional reading and discussions, and our teaching.

The program has met the test of face validity. The staff observed changes in the engagement of students and growth in their written language abilities. The program was valued by the community, receiving media attention and winning awards in the school district's annual Technology Student Showcase for six consecutive years. The awards, which were incorporated into the program to expand successful student writing opportunities included two computers, a video camera, a wireless keyboard, two digital cameras, and flash drives. The program is established and valued; it remains now for scholars to design more formal studies of its component contributions and composite value.

Research Implications

There are many limitations to this case study of the implementation of a theoretically-driven and technology-supported writing program. The program described here is the result of a thoughtful and long-term collaboration, but is not the result of formal study. As noted, a theory of writing guided three important tasks intended to improve student learning outcomes: a review of research on best practices in writing; the

selection and design of instructional approaches based on those best practices; and the careful selection of technologies intended to support various aspects of the writing process, particularly those observed to cause student difficulties.

Several key elements of the program seem to suggest promising directions for more formal research studies. First, it would be useful to conduct a formal quantitative analysis of the program described here, which involved theoretically-driven instructional decision-making and technology-supported writing, learning, and interaction. Relevant student measures might include changes in student motivation to write, written language quantity and quality both within and beyond the classroom, and engagement in lessons.

Second, using models of the writing process (e.g., Flower and Hayes, 1981), researchers might examine the contributions of specific technologies in addressing identified student needs according to the models and the generalized impact of that technology use on overall writing quality. That is, these studies should not be limited to an examination of the effects of the technology-supported intervention on the targeted skill (e.g., spelling, grammar, planning), but should also examine whether use of that technology increased student independence in the writing process and ability to communicate more clearly in written language tasks to specific audiences.

Third, it has been observed that there are a variety of barriers impeding effective integration of technology into classroom instruction. Integration seems to proceed when one of two types of change occur in teacher beliefs. First-order change is that which allows teachers to become more effective and efficient in their teaching without challenging their fundamental beliefs about instruction. Second-order change requires teachers to more deeply examine their beliefs about their current teaching practices and develop new roles and practices (Cuban, 1988; Ertmer, Addison, Lane, Ross, & Woods, 1999). Research might explore the extent to which models with instructional implications (e.g., Flower & Hayes, 1981) enable teachers to make one or both types of change and integrate technology which not only supports their new and deeper understanding of student learning but also allows them to teach more effectively and efficiently.

Along the same lines, an increasing array of technology was integrated over time in this program, but the goal was never to increase technology integration. The goal was to engage students in learning to write. Technologies were initially selected because they addressed an aspect of the model; they were retained in the program because students found them engaging and produced better writing. Researchers might explore more systematically the ways in which theoretically-sound curricular and instructional decision-making leads to successful technology integration.

Conclusions

Samuel Johnson (1811) wrote that, "Marriage has many pains, but celibacy has few pleasures" (p. 92). The program described here represents a successful marriage of theory, research, and practice. It is not without its pains, not the least of which is the need for more formal study now that it has been created. However, it also has many pleasures. Programmatic coherence was achieved by framing instructional decision-making with a theory of writing. Technology integration was organized around the components of the theoretical model and student needs. Students with disabilities and significant literacy needs wrote better and enjoyed it more. And, finally, assistive and

Web-based technologies not only supported student learning and engagement but also expanded their curriculum far beyond the classroom walls.

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Appendix A

Principle Assistive Technologies (AT)/Technologies Used in Program, Purpose, and Teaching Methods

Technologies	Purpose	Teaching Methods Overview
Clicker 4 http://tinyurl.com/3oust7p	To teach students to generate their own ideas rather than copy text.	1) Parents wrote in notebook about their child's interests and activities. 2) *Clicker* grids containing choices with picture support were created based on parents' information (e.g. Hi Jolene, I have a dog/cat. Do you have a pet/brother? Your friend, John) 3) Students created sentences using the picture grid. (e.g., Hi Jolene, I have a cat. Do you have a pet? Your friend, John.) 4) Prompting and modeling were conducted by the SLP as needed to get student choices to match information supplied by parents and to teach topic maintenance. 5) After a sentence was created, the text was sent to the word processor in *Clicker*. 6) Finally, students were taught to select the text, copy it, and paste it into the e-mail.
Co:Writer 6 http://tinyurl.com/lar3hy	To provide spelling and grammar support.	1) A demonstration of *Co:Writer* and guided practice was conducted for students including how to: a. open up *Co:Writer* in e-mail; b. consider what to write and type the first letter of the first word of the message; c. visually scan the resulting predictions using the down arrow key to control speech support as needed; d. select the intended word by either typing its number in the list, using the down arrow key and selecting it, or by using the mouse; e. press the right arrow key for more choices if the intended word was not among the predictions; f. think of and type the second letter in the intended word if the word was still not among the predictions. 2) Additional support and prompting was provided individually or in small groups as needed.

Technologies	Purpose	Teaching Methods Overview
Gaggle https://gaggle.net/	To allow staff to monitor all e-mails on demand and to filter inappropriate content. To provide students with speech support and spellchecking.	1) Usernames and passwords were created for students. 2) Students were taught to: a. open the *Gaggle* site in their browser, enter their usernames and passwords, and then open *Co:Writer*; b. check for new e-mails; c. read new e-mails (with speech support if needed). d. type their e-mails and use spellchecking; e. read over their e-mail messages; f. use speech support in *Gaggle* to read the e-mail again; g. revise or send e-mails as desired; 3) Staff printed e-mails for students to take home and read to family and friends.
VoiceThread http://voicethread.com/	To enable groups to create online texts with teacher guidance and record students reading the texts.	1) Students were read a patterned children's book (e.g., *The Important Book* by Margaret Wise Brown). 2) A template based on the text structure of the book was presented to students in *PowerPoint*™. 3) Students attached *Co:Writer* to a *PowerPoint* slide and wrote an individual page for each of their e-pals (e.g., "The important thing about Linda is that she likes movies just like me.") 4) The resulting class e-book created with *PowerPoint*™ slides was uploaded to *VoiceThread*. 5) Students then used the comment feature in *VoiceThread* to read aloud and record their individually authored slides. 6) The resulting *VoiceThread* e-book was then linked to the Virtual Authors blog.
Blogger http://www.blogger.com	To provide students with (a) a motivating, age-appropriate means of writing and reading, and (b) to present them with other similar tools by embedding free technologies	1) A blog was created with privacy settings to restrict access. 2) With student input, a new question was posted weekly as a blog entry. 3) Students were taught to: a. read the question, examine the accompanying pictures or video, and then click on "comments."

Technologies	Purpose	Teaching Methods Overview
Blogger http://www.blogger.com (*continued*)	To enable family and friends to read and comment on student writing and multimedia projects.	b. attach *Co:Writer* to the comments window, click on "Name," and type their first names. c. Use *Co:Writer* to type their responses, and then clicked on "Publish Your Comment" when they were finished. 4) The college students also responded to the weekly blog questions, thereby providing good written language models. 5) Family and friends were invited to visit the blog and to post responses if they desired.
Animoto http://animoto.com/ *Slide®* http://www.slide.com/ *Flixtime* http://flixtime.com/	To build student background knowledge relative to the weekly questions by creating a variety of video slideshows.	1) Students took turns determining blog questions. 2) SLP controlled the keyboard and web-based tools while students selected pictures and music for the videos. 3) Students attached *Co:Writer* to the pictures in order to write captions. 4) The resulting videos were then linked with the target questions on the blog.
Flickr® http://www.flickr.com/creativecommons/	To remove copyright issues as pictures were inserted into various student projects.	This was a tool used primarily by staff.
Twitter http://twitter.com/	To provide students with a motivating, age-appropriate means of writing and reading that was not overwhelming since tweets are limited to 140 characters.	1) SLP created user names and passwords for students. 2) Privacy settings were selected so that followers had to be approved. 3) Students and teachers were linked to each other. 4) Students were taught to attach *Co:Writ*er to "What's Happening" window to create a tweet.