Writing in a Multimedia Environment: Pilot Outcomes for High School Students in Special Education

Kavita Rao, Peter W. Dowrick, and JoAnn W. L. Yuen,
University of Hawaii at Manoa

Precille C. Boisvert
Hawaii Department of Education

This study examined outcomes of using a generative multimedia environment for writing. Students in grades 9 to 12 enrolled in a special education language arts class participated in an eight-week intervention during which they wrote five stories that included pictures, audio, and text. Stories were scored using a Hawaii standards-based rubric assessment. Statistically significant differences were found when scores on the first and last stories were compared. Teams with lower pretest scores appeared to benefit the most from the intervention. A teacher interview revealed several affective outcomes in student writing behaviors, student engagement, and motivation.

Multimedia software provides teachers with several means by which they can creatively integrate curriculum and instruction with technology. With multimedia software readily available on computers today, schools no longer have to purchase specialized hardware or software to enable students and teachers to make multimedia projects. Using multimedia software to combine, synthesize, and present visual, aural, and textual information, students have the opportunity to exercise control over their learning (Ferreti & Okolo, 1996). Multimodal means of representing information can appeal to a variety of learning styles and preferences and can address instructional objectives through differentiated or modified means.

The purpose of this study was to explore how an intervention using multimedia technology impacted the writing ability of high school students with learning disabilities and emotional or behavioral disabilities. In this study, we utilized a "generative multimedia environment" (a multimedia authoring environment) in which students used computers to write stories that integrated pictures, text, and audio. This multimedia environment, known as TeenACE (Actual Community Empowerment), includes a set of procedures and protocols described in detail in the methods section of this article.

Education and Technology

Teachers seem to be more aware of the motivational benefits of using technology in special education than the academic benefits, but researchers are trying to broaden this understanding by confirming the value of technology and student achievement. Jeffs, Morrison, Messenheimer, Rizza, and Banister (2003) noted that more needs to be done "to illustrate the curricular value of technology that reinforces what we value in education, learning" (p.144). Research has begun to focus on specific issues such as multimedia technology and its impact on different measures of student achievement; the effects of multimedia technology for students with learning disabilities; and the effects of multimedia on writing (Ayersman, 1996; Fan & Orey, 2001; Liu, 2004; MacArthur, Ferretti, Okolo, & Cavalier, 2001). As similar studies focus on specific education issues in defined populations (i.e., learning behavior acquisition in ESL populations),

teachers will realize that technology does not simply motivate; it reengages students in the learning process and improves academics.

The multidimensional nature of a multimedia project has created challenges for researchers who have attempted to assess discrete student achievement outcomes (Fan & Orey, 2001; MacArthur et al., 2001; Williams, 2002; Zhang, 2000). Ferretti and Okolo (1996) noted that traditional student assessments do not measure the multiple and overlapping representations of information that comprise a multimedia project.

Ferretti and Okolo (1996) also examined the effect of multimedia presentation tools on content knowledge of students with learning disabilities. They found both control and treatment groups gained knowledge, but they could not identify effects for multimedia use. Upon closer examination, they acknowledged that the multimedia condition was not implemented as planned (Ferretti & Okolo, 1996). In reality, students did not have sufficient time to use the multimedia tools available to them, and they were only able to insert a picture into their projects. Technology appears to be only as effective as the classroom environment supporting the implementation allows.

Educational theorists believe that involving students in the construction of multimedia projects has potential to improve creativity, problem-solving abilities, and content-area knowledge (Fan & Orey, 2001; Ferretti & Okolo, 1996; MacArthur et al., 2001). TeenACE was designed to identify and support the relevant contextual links within the classroom to maximize the use of technology and promote positive changes in learning behaviors.

Education, Technology, and TeenACE

The process of developing a multimedia project can provide valuable learning experiences for students. Teachers can design these projects to address particular academic and behavioral learning goals. Wissick (1996) concluded, "Possibly the greatest potential of multimedia is that it allows teachers to create environments where students can be researchers and creators of products for reports, becoming experts in certain subjects" (p. 502). She believes the receptive and generative uses of multimedia technology create a sense of "expertise" for students with learning disabilities and promote positive self-esteem. Several studies confirm that multimedia technology does not simply improve student attitudes and behaviors, it improves academic skills.

Descriptive studies using multimedia technology for students with learning disabilities have shown promising results when visual media are incorporated with writing (Daiute & Morse, 1994; Dimitriadi, 2001; Faux, 2005; Zhang, 2000). Faux observed that students gain a sense of independence and remain motivated to engage in the writing process as they work in a multimedia environment. She examined the creative process of high school special education students involved in creating a multimedia-based story. She found that given the opportunity to use multiple representations (pictures, sound, and text) to communicate, students capitalized on their areas of strength. Students first relied heavily on the teacher, but eventually learned to use the tools on the computer to help with the writing process. For example, one student used the aural cues of the text-to-speech function, moving away from the human scaffold of the teacher to the more independent mode of writing using computer-based tools.

Dimitriadi (2001) also found that students improved their reading fluency on passages they had created. Particularly evident throughout the study were students' engagement in language activities and development of authoring skills.

Zhang (2000) conducted a study of multimedia software use and its impact on writing with five fifth grade students with learning disabilities. The protocol used was similar to that implemented in TeenACE. Students used a multimedia environment three times a week for 20-minute sessions to write about a topic of their own choosing or an assigned topic. Their written products were evaluated using a guide for writing assessment that included measures of ideas and content, organization, voice, word choice, sentence fluency, and convention.

All students showed improvements on their written products. One student changed his writing behavior and authored the longest free-writing piece he had ever produced. Another student, with low motivation, produced 10 stories. The student with the most severe disabilities displayed improvements in her writing processes and an aptitude for spelling that teachers had not previously seen. Zhang concluded that purposefully designed appli-

cations of technology can help students with disabilities become better writers and improve learning behaviors.

Daiute and Morse (1994) conducted a case study using generative multimedia and documented participants' progress in writing processes. One student's writing was improved by the use of pictures, and another student wrote more text than he had in the year prior to the multimedia project. His projects became more complex as he made use of images, sounds, and drawing tools and collaborated with adults and peers. A third student also used pictures as a springboard for more creative expression than she had managed prior to the project. The researchers concluded that the students developed their writing more in the multimedia context, in part because they were free to put together pictures, words, and sounds based on their backgrounds and interests. Researchers emphasized the importance of leveraging students' strengths and abilities through the open-ended nature of a multimedia project.

MacArthur et al. (2001), in their review of literature on technology applications for students with literacy problems, concluded that effects of technology on literacy will depend on the design of the intervention, the instruction accompanying it, the ways the intervention is used, and the characteristics of the students using it. They also called for further research on the topic.

As the literature summarized indicates, there are pieces of evidence to suggest the value of instructional multimedia tools for teenagers and the benefit of better writing skills for youth with learning difficulties. However, the evidence is patchy. There is a need for further empirical examination of the instructional context and processes of using multimedia technology and the discrete outcomes of such interventions with particular subsets of students. This article addresses how a multimedia-based intervention can be implemented in the classroom and details the outcomes of the project for high school students enrolled in a special education language arts class.

Theoretical Perspectives

Given the diverse needs of students who receive special education services, principles of social constructivist theory and cognitive constructivist theory provide useful contexts for designing curriculum. Rather than a one-size-fits-all approach, each of these theories encourages the use of flexible and multimodal ways to approach instruction.

According to The Center for Applied Special Technology (CAST), Universal Design for Learning (UDL) principles encourage educators to incorporate flexible goals, methods, materials, and assessments to address the needs of diverse learners. Multimedia technology provides a natural tool to support these principles. CAST identifies three areas of importance within UDL: (a) "multiple means of representation to give learners various ways of acquiring information and knowledge;" (b) "multiple means of expression to provide learners alternatives for demonstrating what they know;" and (c) "multiple means of engagement to tap into learners' interests, offer appropriate challenges and increase motivation" (CAST, n.d., p. 1).

Computers, and their multimedia functions in particular, allow students to access and interact with information in visual, textual, and aural ways. Students who are stronger with one mode of processing information than another can start with their area of strength. For instance, a student who is more comfortable speaking than writing can be encouraged to record a project on the computer before typing his or her text. A student who is motivated by visual stimuli can work with pictures as the prompts for generating thoughts or typing text on the computer.

The social constructivist notions of learning through community and collaboration and the Vygotskian notion of the Zone of Proximal Development (ZPD) were also key to our project design. According to Vygotsky (1962), there is a spectrum along which children think and solve problems. At one end of the spectrum a child can perform tasks independently, and at the other end a child may perform the task only with support from an adult or more capable peer. In between these two extremes lies the ZPD, in which children have the greatest potential to learn—with the help of teachers, parents, and peers—to become more able to solve problems and think independently. In this view, interaction with others is a critical element of learning (Vygotsky, 1962).

Multimedia projects can be designed to allow for many iterative interactions with peers and teachers acting as coaches in the ZPD. If instructors can create learning environments with multimedia technology, they can leverage the existing strengths and interests of teenagers.

Teachers can make tasks incrementally more challenging for the students as proficiency and skill are gained, so that demands stay within the ZPD as the top end of the zone advances. In this model, the teacher acts as a guide for learning, collaborating with the students to achieve learning goals.

Development of TeenACE Reading and Writing

TeenACE was developed with funding from the U. S. Department of Education Community Technology Center grants as part of a suite of supplemental education programs for youth at risk. The intervention addresses the issues and embraces the theories described above, through activities involving high levels of engagement in literacy tasks (writing, reading, discussing plots or choice of words, etc.), in a multimedia environment. The procedures and protocol were piloted and revised with scores of youth in a variety of circumstances (Dowrick & Yuen, 2007). In one trial with ninth graders, 10 English language learners improved dramatically in reading and comprehension. Writing and motivation for schoolwork were believed to improve, but were not systematically measured (Dowrick & Yuen, 2006).

TeenACE, as described here, uses multimedia to enable students to construct their own ways of presenting information. The open-ended nature of multimedia authoring gives students choices and encourages higher-order thinking skills such as analysis, evaluation, and decision making. Students are encouraged to put together pictures, words, and sounds based on their backgrounds and interests. Previous studies of TeenACE had examined its use with English language learners. In this study, we examined the use of TeenACE with another subset of diverse youth considered at academic risk, high school students who were receiving special education services.

Research Questions

The main question of this study was: What impact does the use of multimedia software for authoring stories have on students' written expression? We examined three specific areas of written expression: (a) ability to convey meaning, (b) clarity of writing, and (c) use of conventions. The research team hypothesized that students' use of multimedia software to author stories would improve their written expression, as evidenced by scores on an assessment rubric. We also hypothesized that the TeenACE activities would promote changes in learning behaviors and attitudes, which we sought to explore through qualitative methods.

Methods

Participants and Setting

The second author received a one-year grant to conduct a pilot study at a rural high school on the neighboring island of Hawai'i, which is nearly 200 miles and a 50-minute plane ride from the University, which is located on the island of Oahu. The 2003-2004 School Status and Improvement Report (Accountability Resource Center Hawai'i (ARCH), 2005) for this school indicated that the three most populous ethnic groups in the school were (approximately) Hawaiian/Part-Hawaiian (40%), Caucasian (20%), and Japanese (10%). There was a 30% spread across many other groups.

The participants in this pilot study were a subset of students receiving special education services. According to the latest School Status and Improvement Report (ARCH, 2005), approximately 130 students, or 14% of the population of the school, received special education services. The participants were enrolled in special education language arts classes. Students who have a learning disability classification and are at risk of failing their general education language arts class are assigned to these classes. The teacher responsible for these classes volunteered to be a part of this study.

Since there was a limited number of computers available for the project, we chose class sections with fewer than 12 students in order to keep the computer-to-student ratio at 1:2. Three sections fitting this criterion included tenth grade, eleventh grade, and a small section of mixed grade (9-12) students. The researchers relied on this convenience sample for the study.

Data provided by the teacher indicated that all students in these sections were reading below their grade levels, and none above middle school level according to the Stanford Diagnostic Reading Test (Karlsen & Gardner, 1995). A total of 25 students made up the treatment group for this eight-week intervention. This group in-

cluded 2 ninth grade, 13 tenth grade, 9 eleventh grade, and 1 twelfth grade student; 85% of the students were male, and 15% were female. The ethnic make-up of the group was: Caucasian, 8%; Hispanic, 6%; Hawaiian/ Part Hawaiian, 65%, Asian, 18%; and Pacific Islander, 3%. The average reading grade level (on the Stanford Diagnostic Reading Test) for the participants was 4.3.

Materials and Instrumentation

Students used laptop computers with Classroom Suite IntelliPics Studio software (IntelliTools, 2003) to create their multimedia projects. IntelliTools is a multimedia authoring software that allows for integration of text, pictures, and sound. IntelliTools has a built in text-to-speech function, which reads back typed text. Each student team received a laptop to use during the class period for the duration of the project. Each laptop was equipped with a microphone that allowed students to record narrations.

We provided each team with a set of step-by-step instructions known as the "TeenACE PowerPack." (See procedures section for a description.) Each team also received paper copies of nine picture sets that became the basis for the stories they authored. We installed digital copies of the same picture sets on the laptops.

Research Design

This pilot study was designed to examine growth in writing skills (quantitatively) and the engagement and independence of students in academic work, based on observations by the teacher (primarily qualitative). The school setting did not provide any opportunity for a comparison group, because it integrated the ninth through twelfth grades for special education language arts. There were no routinely required story writing assignments for these students, except through TeenACE.

The study employed a data-driven portfolio assessment method to examine the effects of the multimedia-based intervention on written expression. Mertens (2005) claims that, "This type of assessment is valuable as an alternative to standards based assessments in which students with disabilities may not be able to participate" (p. 369). We based our evaluation of writing samples on a writing rubric from the *Hawaii State Assessment: Interpretive Guide for Reading and Writing* (Harcourt, 2005). The research team chose this assessment method at the request of the school's literacy coordinator, because it fit with the goals of the school and the statewide system. She suggested using this rubric since students in the third, fifth, eighth, and tenth grades would be taking this writing assessment starting in Fall 2006, and would be scored according to the rubric.

To set goals for story writing, the classroom teacher used copies of a standards checklist that was developed by the research team for this project. This checklist was based on Hawaii Content and Performance Standards II writing standards. The teacher was asked to use this checklist to set a baseline for each student team's writing at the beginning of the intervention, and as a guide to set progressively more challenging writing goals for each team during the intervention. At the end of the intervention period, the research team conducted a teacher interview to obtain objective and subjective information on the effects, including the students' affective behaviors.

The primary dependent variable of this study was written expression. Using the rubric, we scored three facets of written expression: (a) ability to convey meaning, (b) clarity of writing, and (c) use of conventions. We based operational definitions for these three areas on the *Hawaii State Assessment: Interpretive Guide for Reading and Writing* (Harcourt, 2005) rubric categories. According to this guide, meaning is defined as "…insight and understanding behind the words…there is a point to the writing…it adds up to something worth reading…" (p. 121). Clarity is defined as "…word choice, language, and sentence structure convey the intended meaning with precision and clarity…" (p. 121). Conventions are defined as "…grasp of standard writing conventions of grammar, capitalization, punctuation, spelling, and paragraphing…" (p. 122).

Student projects were scored using an assessment based on the writing rubric for grades 8 and 10 in the aforementioned interpretive guide (Harcourt, 2005). The categories of meaning, clarity, and conventions were assessed using a unique five-point scale rubric (i.e., each category had a unique set of dimensions that made up a five-point scale) that could yield a total rubric score of 15 points. We made one addition to the meaning category on the HSA rubric to assess a unique feature of the multimedia environment. Because the multimedia projects relied on pictures as prompts for writing, we added a measure

about the written text relating to the picture, an element that standard writing prompts do not include.

Table 1 contains an excerpt from the modified rubric, illustrating how we included an assessment of the picture and text in the meaning category. No other changes were made to the existing Hawaii State Assessment rubric (Harcourt, 2005). The first author developed this measure and served as the rater of the students' stories.

A maturation effect was considered a potential threat to the internal validity in this study (Creswell, 2003). Participating students may have gained writing proficiency as a result of other activities in school during the time between the first and last story. As noted above, circumstances did not allow for the use of a comparison group to control for maturation. However, the period of time between first and last measures was relatively short (<8 weeks), and given their history of difficulties with writing, the teacher did not expect large gains in student writing skill during this time.

Procedure

The students followed a set of protocols in the TeenACE PowerPack. These protocols were developed by the second and third authors of this article under previous grants from the U. S. Office of Vocational and Adult Education (Yuen, Dowrick, & Alaimaleata, 2004). This protocol includes more than 70 simple, explicit steps to guide the youth through the TeenACE process. During the eight-week intervention, students worked on this project three times per week for 50-minute periods. The protocols are outlined in Table 2.

Table 1

Sample of Modified Writing Rubric, Hawaii State Assessment Grades 8 and 10: Meaning

MEANING: Insight and understanding behind the words; there is a point to the writing; it adds up to something worth reading.

5-Point Scale	Dimensions
1	Ideas add up to a message that is *simple and basic*. The meaning or message is straightforward and makes sense but is commonplace. Supporting information, details, and/or examples are ordinary or predictable. [The writer *does not consistently connect text to pictures, demonstrating a lack of understanding* of how words and pictures can be combined to tell a story.]
2	Ideas present some *evidence of thoughtfulness*. Clear message or meaning is conveyed. Writing demonstrates successful attempt to elaborate on some of the supporting information or details. [The writer *connects text to pictures on some pages, demonstrating a weak, but emergent, understanding* of how words and pictures can be combined to tell a story.]
3	Ideas add up to a message showing *evidence of thought and reflection*. The writer used experience and knowledge to "personalize" the message or point and make the topic "real." [The writer *connects text to pictures on a majority of pages, demonstrating a basic understanding* of how words and pictures can be combined to tell a story.]
4	Ideas add up to a message showing some *substance, demonstrating thoughtfulness and reflection*. Writer draws from personal experience or past knowledge, which goes beyond the obvious to support and reveal the message. [The writer *connects text to pictures on each page, demonstrating an acceptable level of understanding* of how words and pictures can be combined to tell a story.]
5	Ideas add up to a message showing *substance and evidence of thought and reflection*. The writer reveals what is significant about the topic and offers "fresh" ideas, perspectives, or arguments essential to the meaning. [The writer *connects text to pictures on each page creatively and thoughtfully, demonstrating a strong understanding* of how words and pictures can be combined to tell a story.]

Note. The text contained inside the brackets represents the text that was added as a modification of the original rubric, to measure ways in which students integrated pictures and text.

Table 2

Overview of TeenACE Protocols by Participant

Participant	Protocols
Teacher	1. Act as facilitator/coach rather than teacher 2. Pair students 3. Based on the standards checklist, provide goals for each team based on their current literacy skills 4. Set incrementally more challenging goals for each team with each new story 5. Encourage students to follow directions in the TeenACE PowerPack 6. Encourage students to collaborate, find and use resources to improve stories
Student	1. Read and follow directions in TeenACE PowerPack 2. Choose a picture set (each set has nine pictures) 3. Write a story collaboratively as a team of two 4. Write the story on the computer using IntelliPics software 5. Use the text-to-speech feature to review story 6. Narrate and record story 7. Share and peer-edit story on the computer 8. Repeat the process with four more picture sets

In several sites where TeenACE has been implemented, researchers and teachers have observed that students quickly learn the steps and refer less and less to the protocol as they become familiar with the process. At the same time, the protocol provides the ideal means for the supervising teacher to ensure that the students are following consistent steps and to ensure fidelity of the implementation.

Students worked in teams of two. The teacher determined the makeup of each team, pairing students who had relatively similar writing abilities. Each team chose picture sets and followed the TeenACE PowerPack directions to collaborate on a creative process for writing and recording its stories. During the writing process, students were directed to share their stories with other teams and to use the text-to-speech function to listen to their stories. These steps acted as a built-in peer review and editing process. The teacher acted as a facilitator, allowing students to work independently for the most part, and setting incrementally more challenging goals for each team as they completed one story and started the next.

Since the school was located on a neighboring island, it was not easily accessible for frequent visits by most of the research team. Given the costs of travel, those of us responsible for implementation training could take only a limited number of trips to the school site.

We conducted an on-site training prior to the start of the project. The classroom teacher and her educational assistant, along with several other teachers and assistants in the school's special education department, participated in this one-day training session. One researcher returned to the site for the first few days of project implementation to assist the teacher in getting started. For the remaining eight weeks, the teacher implemented the project using the step-by-step protocols. To counter the challenge of not being able to observe project implementation first hand, the research team kept in touch with the teacher via email. The teacher was asked to keep a daily log of the implementation process to document progress.

While the location posed a challenge in monitoring intervention fidelity, the research setting provided naturalistic learning experiences. Conducting research despite the challenges of distance and remote locations is important in a state where schools are often a plane ride away. Studies such as this one, where the researchers and school are on different islands, provide opportunities to

investigate the realities of implementation and to analyze which aspects of projects can be done successfully without on-site support, as is necessary when programs are adopted in schools.

Data Collection and Analysis

To measure the primary dependent variable, written expression, the research team used a within-group pre-post assessment of written products created by the students. Each student team was expected to write five stories during the eight weeks. Two researchers used the writing rubric to score the first and last stories written by each team of students. Inter-rater reliability was established using a point-by-point method (Kazdin, 1982) to calculate percentage agreement.

Student scores were analyzed using a comparison of means on correlated samples (pre-post for each student) to report the means, ranges, and standard deviations. We used a paired *t*-test (Best & Kahn, 1998) to measure the statistical significance of the results, using an alpha level of .05.

Results

Table 3 provides the writing rubric raw scores for student teams on the first and last stories they wrote during the eight-week intervention. Each team consisted of two students, assigned by the teacher. In almost all cases, each team wrote five stories. In a few cases, the last story

Table 3

Scores and Group Means for First and Last Stories

Team	First Story Score	Last Story Score	Change in Scores
Group 1: Low Performers			
A	3	9	+6
E	3	8	+5
G	5	8	+3
L	5	3	-2
H	6	11	+5
C	7	9	+2
D	8	9	+1
Group 1 Mean	**5.3**	**8.1**	**+2.8**
Group 2: High Performers			
F	10	7	-3
N	10	11	-2
B	11	12	+1
I	11	12	+1
J	11	12	+1
K	11	10	-1
M	12	12	0
Group 2 Mean	**10.9**	**10.9**	**0**
Cumulative Mean Scores	**8.1**	**9.5**	**+1.4**

was incomplete so the fourth story was evaluated. Stories could get a total of 15 points on the rubric.

The mean scores for the total group increased 1.4 points, from 8.1 for the first story (pretest) to 9.5 for the last story (posttest). A paired *t*-test on these pretest and posttest scores showed a statistically significant difference, $t = 1.77(13)$, $p = .03$.

The pretest scores showed that about half the teams scored significantly lower than their peers. We labeled the teams with the seven lowest scores on their first stories (scores 3-8) the lower performers and the remaining seven teams with higher scores on the first stories (scores 10-12) higher performers. When the pre- and posttest scores of these two groups were compared, a visual examination of the scores revealed that that nearly all the variance came from the lower performers. The pre- and posttest means remained unchanged for the higher performers (10.9), while the means for the lower performers increased almost 3 units (5.3 to 8.1). A paired *t*-test on the pretest and posttest scores of the lower performers confirmed a statistically significant difference, $t = 2.705(6)$, $p = .02$. The effect size for the lower performers was .55, although we hesitate to quote such statistics when the low number of participants threatens the assumptions of the tests.

Findings from Teacher Interview

While the study was focused primarily on changes in writing scores, email communication with the classroom teacher during the intervention and a formal teacher interview conducted at the end of the intervention revealed perceptions of some positive gains for students that were not captured by the writing rubric. These qualitative results on the intervention are summarized in this section. The teacher was interviewed by the first author of this article using a questionnaire designed to collect information on three facets of project implementation: intervention fidelity, student processes, and teacher perceptions of student outcomes. The interview was recorded and transcribed by the first author.

The research team reviewed and hand coded the interview transcripts, looking for recurring themes. This analysis of the teacher's comments revealed five categories of promising gains and positive effects for students during the intervention. Table 4 provides an outline of the five

Table 4

Summary of Findings from Teacher Interview

Category	Outcomes for Students
Benefits of Teamwork	• Sharing stories made students realize that they needed to make the stories interesting • Students relied on peers, rather than teacher, for help
Improvement in Writing	• Realized "ingredients of a story" such as character, plot development and flow • Added more details to communicate complete thoughts
Self-Efficacy and Independence	• Initially students—not used to self-directed learning—asked for directions; as projects progressed students were motivated to work independently • Worked independently during class session; took computers and worked instead of waiting for direction • Persevered even when they felt they had "writer's block" • Engaged in writing for longer periods of time than other classroom activities
Confidence	• Gained confidence that "I can" create sentences and write
Generalized to Other Skills	• Gained practical computer and word processing skills • Used text-to-speech function of computer to hear misspelled words and found spell check feature on software to further correct words

categories and summaries of the comments made by the teacher.

The teacher spoke of several behavioral and affective gains. She emphasized that students exhibited an increased sense of independence during this project in her answers to several questions. Students were self-directed in starting the project during the class periods dedicated to it. They appeared to learn to seek answers from each other and rely less on the teacher for guidance. She commented that many of her students receiving special education services had gotten used to asking for answers from teachers rather than seeking their own, so this self-reliance was a marked difference from past behavior.

The teacher mentioned that they seemed to gain a sense of what constituted good writing through various processes that the TeenACE project protocols required. One requirement of the project was to share stories with other teams. Students realized that they needed to make their stories more "interesting," and use longer, more descriptive sentences and details to hold the attention of their peer readers. The teacher stated, "I think they were able to use the stories to improve their writing and know what a good piece of writing sounds and looks like." In the process, students seemed to begin to see themselves as capable writers who could piece together several sentences into a coherent story.

The project also impacted affective student behavior. Students showed increased confidence in their ability to put sentences together. They persevered despite moments of "writer's block," and they stayed engaged. The teacher mentioned that students became bored with the restricted selection of picture sets and asked if they could bring in and use their own pictures. The TeenACE protocol offers this option after the first five stories. Thus, we encouraged the teacher to let students create their own picture sets after they completed the initial eight-week phase.

Discussion

The results and findings from the quantitative and qualitative aspects of this study are consistent with literature on similar interventions. The fact that the lower performers had more variance than the higher performers may result from a variety of factors. There is the possibility of a ceiling effect for the higher performers. On the 15-point rubric, the students with higher writing proficiency had less room to improve.

A study by Carlin-Menter and Schuell (2003) that examined multimedia projects and organizational writing skills had similar findings. The most significant outcome of their study was the increase in organizational quality of traditional written essays for students with the lowest pretest scores. The high scoring students did not show marked improvement. The researchers ascribed this finding to a ceiling effect.

In our study, it also is possible that the high performers improved on other measures of writing that the rubric did not capture. The teams that scored lower on their first stories had more opportunities to improve on the rubric measures. As stated in the teacher interviews, teams in general learned to write with more clarity and meaning for peer review. Both these facets of writing were measured by the rubric. This change could have been more noticeable with the lower performers.

TeenACE requires the teacher to set incrementally more challenging goals for each story that student teams write during the eight weeks. These goals will vary for each team, depending on their individual weaknesses and strengths. Using a checklist with state content and performance standards, the teacher is encouraged to provide each team with new challenges.

The teacher who participated in this study was implementing the project for the first time. She stated that she did set more challenging goals for the first few stories, but became less consistent as the weeks progressed. The inconsistency may have been a product of the competing demands faced by many classroom teachers. This lapse in goal setting could have had a bearing in the student results for the higher performing group. Without more challenging goals set for them, the students probably lacked incentive or direction for what to work on and improve.

As teachers implement the TeenACE project multiple times and become familiar with the different aspects of managing the project, they will gain proficiency in setting new goals. Future studies with teachers who have implemented TeenACE more than once can examine if a

teacher's experience with goal setting within the project impacts teams that have higher scores at the beginning of the intervention.

The intervention also may have addressed the Zone of Proximal Development for the lower scoring students. They may have benefited from the experience of writing with a peer. As the teacher interview data revealed, students learned to rely on each other to answer questions that arose.

In a study in which elementary age students wrote stories in a multimedia environment, Daiute and Morse (1994) noted the importance of broadening the range of contexts and symbol systems available to children with disabilities. They suggested that writing should be considered as one among several systems that children can use for learning and expression. Based on the outcomes from the case studies, they concluded that writers all appeared to be more developed than previously demonstrated. They attributed this to working with multiple media in the Zone of Proximal Development.

Two studies of writing in a multimedia environment corroborated the teacher's observation that students used the software's text-to-speech function to correct their own spelling and grammar. Both Zhang (2000) and Faux (2005) noted that students seemed uncommonly motivated to use the software's text-to-speech feature to listen and find spelling errors.

Limitations

The potential narrowness of the measure used to assess writing is one of three limitations of this pilot study to be addressed in further research. While the content validity of devising a measure based on the published state standards is obvious, that was traded against the external validity and reliability of using a nationally standardized measure such as the writing fluency or editing subtests of the Woodcock Johnson III. The actual changes in writing performance may have been greater than those measured (rated), as the first stories were not pretests, but instead the first artifacts created during the intervention period to be compared with the final artifact (fifth story). Other limitations, as previously noted, were the lack of a comparison group and the unavailability of direct observation, both traded against the desirability of evaluating the program in a remote location. We are now hopeful of pursuing fully funded efficacy trials that will address these limitations.

Conclusion

Using a multimedia environment to author a story provides students with nontraditional avenues to practice and gain confidence with their writing skills. By the time they reach high school, students who have had trouble writing have deeply ingrained notions of their low skill levels in this area. Projects such as TeenACE give students with disabilities alternative ways to practice writing, adding the elements of collaboration, computer use, and visual and aural media. For students with literacy-related learning disabilities, these facets of writing in a multimedia environment hold promise as ways for students to see themselves as capable writers, while practicing the mechanics of writing.

Future studies can examine several variations of this project. Studies of this sort that utilize a control group and treatment group could help examine how the multimedia environment compares to traditional writing activities. In addition, the effects of student choice to use computers to write and potential longitudinal gains from an intervention such as this are worth examining. As computers become an essential tool that students use as readily as a pencil or pen, researchers can benefit from examining the potential of using multimedia software to help students with intellectual and learning disabilities gain proficiency and confidence in their literacy skills.

References

Accountability Resource Center Hawai'i (ARCH). (2005). *School status and improvement report*. Retrieved October 2, 2005 from http://arch.k12.hi.us/pdf/ssir/2004/Hawai'i/SSIR374-5.pdf

Ayersman, D. J. (1996). Reviewing the research on hypermedia-based learning. *Journal of Research on Computing in Education, 28*, 500-525.

Best, J. W., & Kahn, J. V. (1998). *Research in education*. Boston: Allyn and Bacon.

Brooks, J. G., & Brooks, M. G. (1993). *In search of understanding: The case for constructivist classrooms*. Alexandria, VA: Association for Supervision and Curriculum Development.

Carlin-Menter, S. M., & Schuell, T. J. (2003). Teaching writing strategies through multimedia authorship. *Journal of Educational Multimedia and Hypermedia, 12*, 315-334.

Center for Applied Special Technology. (n.d.). *What is universal design for learning*? Retrieved October 2, 2005, from http://www.cast.org/research/udl/index.html

Creswell, J. W. (2003). *Research design: Qualitative, quantitative, and mixed method approaches*. Thousand Oaks, CA: Sage.

Daiute, C., & Morse, F. (1994). Access to knowledge and expression: Multimedia writing tools for students with diverse needs and strengths. *Journal of Special Education Technology, 12*(3), 221-256.

Dimitriadi, Y. (2001). Evaluating the use of multimedia authoring with dyslexic learners: A case study. *British Journal of Educational Technology*, *32*, 265-276.

Dowrick, P. W. & Yuen, J. W. L. (2006). Teenage literacy: Pilot study in Hawaii. *Asia Pacific Journal of Inclusive Education, 3*, 1-20.

Dowrick, P. W., & Yuen, J. W. L. (2007). *Multimedia for literacy in English language learners with disabilities* (Award # H327A070023). Washington, DC: U. S. Office of Special Education Programs.

Fan, H. L., & Orey, M. (2001). Multimedia in the classroom: Its effect on student writing ability. *Journal of Research on Technology in Education, 33*(5), 16-24.

Faux, F. (2005). Multimodality: How students with special educational needs create multimedia stories. *Education, Communication and Information, 5*, 167-181.

Ferretti, R. P., & Okolo, C. M. (1996). Authenticity in learning: Multimedia design projects in the social studies for students with. *Journal of Learning Disabilities, 29*, 450-461.

Harcourt. (2005). *Hawaii state assessment: Interpretive guide for reading and writing*. (6th ed.). San Antonio, TX: Author.

IntelliTools. (2003). *IntelliPics Studio 3*. Petaluma, CA: Author.

Jeffs, T., Morrison, W., Messenheimer, T., Rizza, M., & Banister, S. (2003). A retrospective analysis of technological advancements in special education. *Computers in the Schools, 20*(1-2), 129-152.

Karlsen, B., & Gardner, E. (1995). *Stanford Diagnostic Reading Test* (4th ed., SDRT-4). San Antonio, TX: Psychological Corporation.

Kazdin, A. E. (1982). *Single-case research designs: Methods for clinical and applied settings*. New York: Oxford University Press.

Liu, M. (2004). Examining the performance and attitudes of sixth graders during their use of a problem-based hypermedia learning environment. *Computers in Human Behavior, 20*, 357-379.

MacArthur, C., Ferreti, R., Okolo, C., & Cavalier, A. (2001). Technology applications for students with literacy problems: A critical review. *The Elementary School Journal, 101*, 273-301.

Mertens, D. M. (2005). *Research and evaluation in education and psychology*. Thousand Oaks, CA: Sage.

Vygotsky, L. S. (1962). *Thought and language*. Cambridge, MA: Massachusetts Institute of Technology Press.

Williams, S. C. (2002). How speech-feedback and word-prediction software can help students write. *Teaching Exceptional Children*, *34*(3), 72-79.

Wissick, C. A. (1996). Multimedia: Enhancing instruction for students with learning disabilities. *Journal of Learning Disabilities, 29*, 494-504.

Yuen, J. W. L., Dowrick, P. W., & Alaimaleata, E. T. (2004). *Full TLT2: Teen Literacy [and Math] through Technology, Community Technology Centers in Kalihi, Oahu, and American Samoa*. Grant awarded by the U. S Department of Education, Office of Vocational and Adult Education, Federal Award ID# V341A040203. Washington DC: U. S Department of Education.

Zhang, L. (2000). Technology and writing skills of students with learning disabilities. *Journal of Research on Computing in Education, 32*, 467-479.

Author Notes

Kavita Rao is an assistant professor in the Department of Special Education, Peter W. Dowrick is professor of disability studies and graduate studies in Psychology (Community and Culture), and JoAnn W. L. Yuen is an associate professor of disability studies at the Center on Disability Studies, in the College of Education, all at the at the University of Hawaii at Manoa. Precille C. Boisvert is the English language learner resource teacher for the West Hawaii Complex Area, Hawaii Department of Education. .

Partial support for this project was provided by a grant to the second author funded by the U. S. Department of Education under the Elementary and Secondary Education Act, Title II, Part A (S367B060012/01). We thank staff at the school and students who participated in this project.

Correspondence should be sent to Kavita Rao, Department of Special Education, College of Education, University of Hawaii at Manoa, 1776 University Avenue, Wist 120, Honolulu, HI 96822. Email to kavitar@hawaii.edu