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Effects of Technology-Enhanced Practice on Scoring Accuracy of Oral Reading Fluency

Paul J. Riccomini
Pamela M. Stecker
Clemson University

Two types of independent practice activities to improve accuracy of pre-service teachers' measurement of oral reading fluency (ORF) were contrasted. Forty pre-service teachers, enrolled in an introductory special education course, received instructor-delivered classroom instruction on measuring ORF. After lecture and guided practice, participants were divided randomly into two groups. Each group practiced assessing ORF either with classmates acting as student readers or by accessing a Web page containing audio clips of stories read by an adult acting as a student reader. Two weeks after the practice session, participants were evaluated on their accuracy. Results indicated that pre-service teachers in the technology-enhanced practice condition reduced their scoring errors to the same degree as teachers did in the traditional practice format.

Today, university course instructors have the opportunity to use the World Wide Web (WWW) in a variety of modes. It is estimated that 97% of university faculty and staff have access to the WWW, and 40% use Web sites to post course-related information (U.S. Department of Education, 2001). In addition to placing specific course materials, such as syllabi, and supplementary project information, on the Web, instructors may place entire courses on the Web using a variety of instructional formats (e.g., streamed audio and video lectures, chat rooms, assignments, and exams). Universities are racing to offer a variety of courses online. In 1998, approximately 710,000 students were enrolled in at least one online course; Meister (2000) predicted this figure would surpass 2.2 million in 2002 and would continue to increase steadily.

Through the development and implementation of instructional technology in university settings, educators realize many benefits of using instructional technology as compared to traditional classroom instructional formats (Hartley, 1999; Hughes & Hewson, 1998; Meyen, Tamgen & Lian, 1999; Yong, 1998). However, the sudden increase of technologies at the university level has left many of the purported benefits largely invalidated. Simply put, researchers have not produced enough empirical data for a synthesis of best practices to guide the use of instructional technology. Rather, the current literature addressing the use of instructional technology is largely comprised of testimonials and descriptions reporting only implementation and design features (Ludlow, 2001; Meyen et al., 2002; Riccomini, 2002); therefore, this new form of instructional design and delivery (i.e., e-pedagogy) has emerged with little regard to research validation.

A logical starting point for educators and researchers in the evaluation of instructional technology modes is the literature base for undergraduate education (Chickering & Ehrmann, 1996; Chickering & Gamson, 1987; Chickering & Gamson, 1999). In response to criticisms of higher education, such as apathy exhibited by students, illiteracy among graduate students, and incompetence among teachers, Chickering and Gamson articulated seven principles of good undergraduate education, first in 1987 and updated later in 1999. These seven principles of good undergraduate education include the following: (a) contact between students and faculty, (b) development of reciprocity and cooperation among students, (c) use of active learning techniques, (d) provision of prompt feedback, (e) emphasis on time on task, (f) communication of high expectations, and (g) respect for diverse talents and ways of learning (Chickering & Gamson, 1987, 1999).

Instructional technology design and delivery based on all or most of the principles of good undergraduate education should produce positive learner outcomes. For example, technology enables professors to provide students with multiple opportunities for active learning, which may be simpler and more effective than traditional practices. Additionally, technology allows for student responses to be evaluated very quickly, so students can receive almost immediate feedback on their performance. The continued use of various instructional technology modes (e.g., Web-based learning, e-learning, streamed audio and video, and online courses) by institutions of higher education warrants a systematic investigation of the effectiveness of the seven principles of good undergraduate education when incorporated into Web-based learning. Knowledge derived from such systematic investigations should guide ongoing development of sound and effective e-pedagogy. The current study details one way technology-enhanced instructional practice can be compared to traditional classroom practice when pre-service teachers learn to score oral reading samples.

Rationale for Instruction in Oral Reading Fluency

Few individuals would disagree with the notion that the ultimate goal of reading is comprehension. However, for reading to be useful to the individual, one must have the ability to access text easily and quickly. Laborious, word-by-word reading not only is frustrating to the individual performing the reading task, but it does little to aid comprehension. Reading well comprises not only a functional skill, but it remains one of the most critical skills for adult competence in today's society. Because fluent reading correlates highly and positively with reading comprehension (Deno, 1985), teachers may use oral reading fluency (ORF) to estimate a student's overall reading achievement. In their rigorous review of reading research, the National Reading Panel (National Institutes of Child Health and Human Development, 2000) concluded that fluency is a critical reading skill not only as a measure for determining overall reading competence, but it encompasses an important skill for teacher-directed instruction and student practice. Although the emphasis on developing ORF often lies with younger students as they learn to read and negotiate meaning, middle and high school students with reading disabilities typically are not fluent with text. Consequently, knowing how to conduct ORF assessment with students of all ages may help teachers in making decisions about student performance and in determining the need for fluency building.

Simply stated, ORF is the number of words read aloud correctly in 1 minute. Teachers may utilize ORF in several ways. Teachers may instruct students to become fluent readers through modeling and repeated practice. They can assess ORF directly to gauge overall reading performance. Teachers can compare an individual's ORF score against typical student benchmarks and make normative comparisons about satisfactory performance. Moreover, teachers can graph a student's ORF scores on multiple occasions across time to determine whether that student's progress appears sufficient for meeting benchmarks or long-term goals. In fact, curriculum-based measurement (CBM) (Deno 1985, 1992) encompasses a research-validated assessment methodology that has incorporated ORF over the past 25-30 years as a measure for evaluating overall student progress in the reading curriculum and for determining the adequacy of the teacher's instruction. In other words, CBM is used to chart student growth across the year and to determine (a) when the instructional program appears to effect appropriate student growth, thereby indicating the need for goal raising and (b) when the instructional program appears to be inadequate for producing desired achievement, thus necessitating the need for instructional modification.

Purpose of the Investigation

Background. The course of interest was an introductory level course in special education, a required course for all students seeking teacher certification. Given the nature of this course, with emphasis on legal aspects, characteristics and identification of varying exceptionalities, and the general educators' role in identifying and providing services to students with exceptionalities, little time was available to teach specific inclusionary practices. However, CBM is a research-validated assessment methodology that teachers can use to build more effective programs for students both with and without disabilities in reading, spelling, written expression, mathematics, content areas, and early literacy (Deno, 1985, 2003; Fuchs & Deno, 1991; Shinn, 1989, 1998). Additionally, CBM has relevance for students across a variety of disability and age groups. Given that the majority of students with disabilities experience difficulties with literacy and that most of these pre-service teachers would not have another opportunity in their programs to learn how to collect ORF data, researchers decided to include in the course an overview in CBM methodology and data interpretation and instruction in how to collect ORF data accurately.

Problem. Previous experience in teaching ORF methods to pre-service teachers indicated that practice of ORF tasks during class could become very time consuming. For example, after the modeling and explanation of administration procedures and scoring conventions, pre-service teachers typically used in-class time to practice activities. Often, class members practiced scoring while the instructor read aloud one or more passages containing predetermined sets of miscues, and participants compared their scoring of passages against prepared scoring keys. Then, in small groups, pre-service teachers took turns reading passages to each other and making miscues, so listeners could become accurate and fluent with scoring rules. Although typical practice activities were effective for producing accuracy and fluency with scoring conventions, they were time consuming.

In an effort to enhance the practice component for scoring ORF and, ultimately, to reduce in-class time devoted to practice, researchers developed a technology-enhanced practice component for scoring ORF that provided multiple opportunities for practice with feedback and potentially could be used outside of class. Therefore, the purpose of this study was to examine the effectiveness of technology-enhanced independent practice versus traditional classroom independent practice on the accuracy of ORF scoring by pre-service teachers.

Research questions. Specifically, the following research questions were addressed: Can technology-enhanced practice produce similar or better results than in-class practice activities on the accuracy of scoring ORF? How do pre-service teachers rate the usefulness of technology-enhanced practice?

Methods

This study examined the effects of a technology-enhanced practice activity on the accuracy of pre-service teachers' scoring of ORF following instruction on measurement procedures. All participants received one, 60-minute lecture on basic principles of CBM (Deno, 1985, 1992), importance of assessing fluency, and procedures for scoring ORF in text in a traditional, classroom format. Following initial instruction and a pretest on accuracy of scoring ORF, participants were divided randomly into two groups. Both groups practiced scoring ORF either with classmates acting as student readers or by accessing a Web page containing audio clips of stories read by an adult acting as a student reader. Two weeks after the practice session, participants were evaluated on their accuracy of scoring ORF.

Participants

Forty undergraduates in teacher education enrolled in an introductory special education course volunteered to participate in this study. Of the 40 pre-service teachers, 29 were candidates in secondary education certification programs, 4 in elementary education, 4 in early childhood education; and 3 in technology education. Participants included 3 sophomores, 7 juniors, and 30 seniors; 28 participants were female. Only 1 of the 40 participants reported having learned about CBM in a previous course.

Setting

The study was conducted at a land-grant university in the southeastern part of the United States. Course instruction took place in a classroom across the hall from a computer lab. The nearby computer lab was used for the Web-based practice activities. The computer lab contained 20 Macintosh computers.

Design

This study examined the effects of a technology-enhanced practice activity on the accuracy of ORF measurement by pre-service teachers after they had received instruction in scoring conventions. A pretest-posttest control group design was used. The participants (n = 40) were assigned randomly to two groups: 20 pre-service teachers were assigned to a traditional, in-class practice group, and 20 pre-service teachers were assigned to a technology-enhanced practice group. The in-class practice group consisted of 13 females and 7 males; 2 sophomores, 2 juniors, and 16 seniors; and 16 secondary, 2 elementary, 1 early childhood, and 1 technology education major. The technology-enhanced practice group consisted of 15 females and 5 males; 1 sophomore, 5 juniors, and 14 seniors; and 12 secondary, 4 elementary, 2 early childhood, and 2 technology education majors. Chi square analyses revealed no significant differences between the two groups on demographic variables of gender, ($X^2(1, N = 40) = .476$, $p = .490$) classification by year ($X^2(2, N = 40) = 1.572$, $p = .416$), and major ($X^2(3, N = 40) = 1.95$, $p = .592$).

Materials

Using basal reading textbooks available from the School of Education's Media Center, the researchers developed all instructional, practice, and assessment materials for the study. For all the ORF activities and assessments, excerpts from stories at the 4th- and 5th-grade levels were taken from *Scott, Foresman Reading: An American Tradition* series (1989) and varied between 200-275 words in length.

In-class practice materials. Practice materials consisted of one page of text retyped from the beginning of each of two passages and one page from midway through one of the passages. Although none of the one-page passages showed the story to completion, each one page of text contained at least 200 words, exclusive of the title and author.

Technology-enhanced practice materials. The course Web page consisted of a main welcome page with links to the three practice activities (i.e., Story 1, Story 2, and Story 3) used for this study. These three passages were the same as the ones used for in-class, traditional practice. Each practice activity page for story reading contained two links (see Figure 1). The first link contained the digital audio clip of the story. The digital audio sequences ranged in size from 8.7 to 9.6 megabytes. The second link contained a scored key of the digital audio story (see Figure 2).

Dependent Measures

Participants were evaluated on the accuracy of measuring ORF based on specified scoring procedures. An excerpt taken from two different passages was read aloud for the pre- and posttest. Pre-service teachers were required to mark clearly through any word not read aloud correctly and to tally the total number of words that were read correctly, placing this score on the page prior to submitting measures to the researcher. The score used for data analysis was the number of scoring discrepancies exhibited between the pre-service teacher's marking of the protocol and the standard key used by the researcher during pre- and posttest administration.

Pretest. The pretest passage excerpt used to assess pre-service teachers' initial accuracy in scoring ORF was taken

Figure 1. Screen image of Web-based practice activity.

Note. Passage excerpt adapted from Rounds, G. (1989). The day the circus came to Lone Tree. In *Scott, Foresman reading: An American tradition*. Glenview, IL: Scott, Foresman.

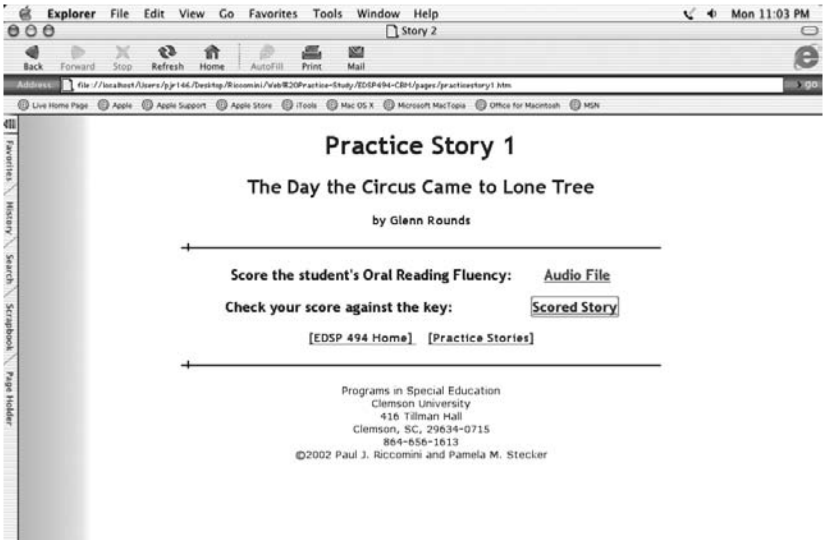
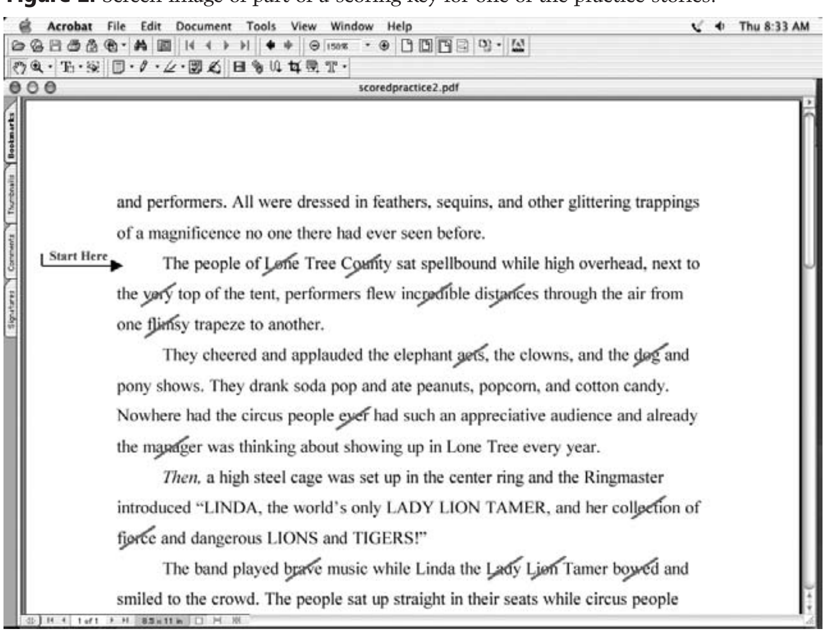


Figure 2. Screen image of part of a scoring key for one of the practice stories.



from a story entitled, *Chino's Tale*, by Mary Stolz (Scott, Foresman; 1989). The researcher read aloud 165 correct words with 35 miscues.

Posttest. The posttest passage excerpt used to assess pre-service teachers' accuracy in scoring ORF following practice activities was taken from a story entitled, *Rhyming Ink*, by Margaret Baker (Scott, Foresman; 1989). The researcher read aloud 188 correct words with 36 miscues.

Pre-service teacher questionnaires. Prior to posttest administration, pre-service teachers completed a brief questionnaire, in which they responded to demographic items about gender, classification, and major and whether they had been taught previously about CBM as a method for scoring ORF. Pre-service teachers also were asked to rate their knowledge of ORF measurement prior to instruction and following practice activities (rated on a 5-point Likert-type scale where 1 = very weak, 2 = weak, 3 = moderate knowledge, 4 = know well, 5 = know very well). Individuals rated the usefulness of their particular practice activities for familiarizing someone with ORF and for learning to score ORF accurately (rated on a 4-point Likert-type scale where 0 = not useful, 1 = a little useful, 2 = useful, 3 = very useful). Additionally, open-ended items allowed pre-service teachers to comment on aspects of the practice activities that were particularly helpful as well as aspects that could be improved.

Procedures

All participants received an hour lecture on the utility of CBM and scoring conventions for ORF. One of the researchers modeled the scoring of a passage read aloud, making predetermined miscues and simultaneously marking an overhead transparency to show miscues as they occurred. Following the model, the researcher reviewed all the scoring rules and pre-service teachers were given the opportunity to practice scoring a passage read to them by the researcher. Corrective feedback was given by providing pre-service teachers with a hard copy of the same passage already scored and any discrepancies were discussed.

After participants practiced applying scoring rules to the guided practice passage, the researcher read a new passage to the group while students marked miscues. This passage was not discussed and served as pretest information. Then, pre-service teachers were assigned randomly to one of two practice conditions. Participants remained either in the classroom with one researcher to practice scoring ORF in small groups or went to a computer lab with the other researcher to practice scoring ORF independently at the computer.

In-class practice. Participants were provided with a set of four stories to practice administering and scoring ORF. Groups of 4 participants were assigned in which each member assumed the role of the student reader once and the role of test administrator/scorer three times, thus providing each class member with three opportunities to score ORF. Each participant assuming the role as a student reader marked his or her own copy to reflect at least 25 miscues prior to reading the story aloud. The student readers were instructed to read the page the same way he or she had marked the miscues while the other three group members served as scorers. After reading each passage, the members within each group compared their scoring results and discussed any scoring discrepancies. The researcher monitored on-task behaviors and answered any questions stemming from the group practice activities. This practice format paralleled the technology-enhanced practice condition with the same number of practice opportunities (i.e., three stories read) and lasted approximately 60 minutes.

Technology-enhanced practice. Each pre-service teacher was assigned a computer to complete Web-based practice activities independently. One of the researchers explained how to use the course Web page and then gave directions for completing the Web-based practice activities. Due to time constraints and printer accessibility, participants were provided with a paper copy of each practice story appearing on the Web page in order to mark miscues.

For the technology-enhanced practice activity, pre-service teachers listened to a set of three digital audio clips on the course Web page. Each digital audio clip was 1 to 1 ½ minutes in duration. Participants marked miscues according to scoring procedures and then compared their marked copies to the scoring keys provided on the Web page. Following the scoring of each practice story, pre-service teachers were instructed to compare their passage against the answer key. If any discrepancies were noted, the individual was instructed to listen again to the same digital clip to reconcile differences. If a participant scored the ORF accurately with no discrepancies, he or she proceeded to the next practice story. The researcher monitored the class for on-task behaviors and answered any questions. The technology-enhanced practice session lasted approximately 60 minutes.

Two weeks later, pre-service teachers were assessed on their accuracy in scoring ORF. The posttest was another passage excerpt from the Scott, Foresman series (1989). Pre-service teachers were instructed to mark miscues and to total the number of words read correctly during the oral reading. Prior to posttest administration, participants completed a brief questionnaire about demographic information and rated their initial and posttest levels of knowledge of scoring ORF as well as the usefulness of their practice activities.

Inter-rater agreement. The ORF protocols were evaluated by trained student assistants who were blind to the purpose of the research and to group assignment. A scoring key was provided against which to compare pre-service teacher responses. A reliability check was performed on 20% of randomly selected protocols from both pretests and posttests. Inter-rater agreement was calculated as the number of agreements divided by the sum of number of agreements and disagreements and was multiplied by 100. Inter-rater agreement ranged from 95.5% to 100% with a mean of 99.9%.

Results

Oral Reading Miscues

Data were analyzed using a 2 x 2 Analysis of Variance with repeated measures with treatment (technology-enhanced practice vs. traditional, in-class practice) as a between-subjects factor and time (pretest vs. posttest) as a within-subjects factor. The interaction between treatment and time was not significant, F (1, 38) = 1.450, p = .236. The main effect for time was significant, F (1, 38) = 93.675, p < .0001. Therefore, discrepancy scores for all participants decreased significantly from pretest (M = 10.350, SD = 4.342) to posttest (M = 4.925, SD = 3.931), resulting in increased scoring accuracy across both practice groups. Table 1 provides a breakdown of means and standard deviations for the technology-enhanced practice group and the traditional, in-class practice group.

Participants' Questionnaire Ratings

Ratings of oral reading measurement knowledge. The oral reading measurement knowledge ratings (i.e., 1 = very weak, 2 = weak, 3 = moderate knowledge, 4 = know well, 5 = know very well) were analyzed using a 2 x 2 Analysis of Variance with repeated measures with treatment (technology-enhanced practice vs. traditional, in-class practice) as a between-subjects factor and time (pretest vs. posttest) as a within-subjects factor. The interaction between treatment and time was not significant, F (1, 38) = .672, p = .418. The main effect for time was significant, F (1, 38) = 263.393, p < .0001. Consequently, ratings of oral reading measurement knowledge increased for all participants from pretest (M = 1.35, SD = .662) to posttest (M = 3.825, SD = .675).

Table 1.
Mean Discrepancy Scores for Recording Oral Reading Miscues by Practice Group

	Scoring discrepancies	
Practice group	Pretest *M (SD)*	Posttest *M (SD)*
Technology-enhanced practice	11.250 (3.837)	9.450 (4.718)
Traditional, in-class practice	5.150 (4.017)	4.700 (3.935)

Usefulness of practice activities for initial familiarity. The participants' ratings (i.e., 0 = not useful, 1 = a little useful, 2 = useful, 3 = very useful) of the practice activities (i.e., either technology-enhanced practice or traditional, in-class practice) for initial learning and familiarity with oral reading measurement were analyzed using independent-samples t test. The group using the computer to practice scoring miscues rated the practice activities higher (M = 2.75, SD =

.444) than did the group scoring miscues without a computer ($M = 2.35$, $SD = .745$). This difference was significant, $t(38) = 2.062$, $p < .05$.

Usefulness of practice activities for developing accuracy. The participants' ratings (i.e., 0 = not useful, 1 = a little useful, 2 = useful, 3 = very useful) of their practice activities for developing accuracy in scoring of oral reading measurement were analyzed using independent-samples t test. Participants rated the computer practice activities for developing accuracy in scoring ($M = 2.65$ $SD = .587$) similarly to participants not using the computer for practice activities ($M = 2.40$, $SD = .681$; $t(38) = 1.244$, ns).

Discussion

The study was conducted to determine whether similar or higher levels of accuracy on ORF scoring could be achieved for technology-enhanced practice compared to traditional, in-class practice conducted within small groups of peers. Following initial instruction and guided practice during class, half the pre-service teachers accessed a Web page independently and practiced scoring ORF for three passages that were provided through audio clips. Pre-service teachers then compared their scoring of individual words for each passage read against the Web-provided model. If any discrepancies were noted, they accessed the audio clip to listen to the passage being read again exactly as it had been read originally. Pre-service teachers in the traditional, in-class practice condition practiced scoring the same number of passages overall, but practiced in groups with three other peers. Consequently, four passages were used (as opposed to three) in the cooperative groups; however, individuals rotated serving as the student reader within each group, so each group member actually scored ORF for only three passages. Because student readers had previously marked their copies of the passages with the miscues they were to read, corrective feedback was given to the entire group regarding accuracy of scoring. Posttest results indicated that pre-service teachers became significantly more accurate in scoring oral reading miscues following practice, but neither condition outperformed the other. Thus, the technology-enhanced practice group performed as well at posttest as did the traditional, in-class practice group.

Differences between the two practice conditions included preparation of the miscues to be read and the format for feedback given to individual scorers. Although pre-service teachers in both conditions practiced scoring three passages that were read aloud, in-class practice activities involved pre-service teachers preparing their own miscues for the passages they read within their cooperative groups. Feedback was given according to the individual reader's marked copy. Pre-service teachers were able to discuss discrepancies and to ask each other questions; however, no recording devices were used, so verification of the exact reading of the passage could not be made. In the technology-enhanced practice group, pre-service teachers listened to audio clips of passages read by one of the researchers and scored ORF independently at the computer. Consequently, peers did not discuss scoring with each other, but they were able to compare their marked passages against the answer key provided at the computer and could listen to audio clips repeatedly in order to reconcile any discrepancies in scoring.

Rating scales indicated that pre-service teachers in both conditions increased their knowledge about oral reading measurement significantly as a result of instruction and practice activities, and they rated the usefulness of their practice activities for developing accuracy in scoring oral reading measurement comparably. However, pre-service teachers in the technology-enhanced condition rated their practice activities significantly higher than pre-service teachers conducting traditional, in-class practice activities with respect to usefulness of the activity for learning about or becoming more familiar with oral reading measurement. Thus, pre-service teachers indicated a marginal preference for the technology-enhanced practice activities.

Additionally, some of the pre-service teachers in the technology-enhanced practice group reported that active engagement in Web-based practice opportunities was very helpful and even enjoyable (e.g., *I learned a lot more about ORF by practicing it instead of just listening to someone talk about it*). This active engagement and repeated practice opportunities allowed participants to become comfortable and accurate with the scoring procedures. Other positive comments were related to corrective feedback being immediately available. Pre-service teachers reported that corrective feedback and opportunities to listen to the audio clip again were very helpful for improving their accuracy (e.g., *It allowed me to listen a second time to catch my mistakes*). These comments are consistent with the recommendations made by Chickering and Gamson (1987, 1999) regarding effective practices for undergraduate education. The pre-service teachers' only criticisms regarding the technology-enhanced practice activity pertained to difficulties hearing the audio (e.g., *Sometimes it is hard to hear endings of words*). Overall, however, the pre-service teachers' written comments were very positive regarding the use of the technology-enhanced practice activities. Likewise, comments made by the pre-service teachers participating in the traditional, in-class practice indicated that they enjoyed the group activities but that they also had difficulties hearing the readers at times.

Limitations

Goals for using technology-enhanced practice included the opportunity for pre-service teachers to practice scoring passages outside of class time, immediate access to corrective feedback, and development of a high level of accuracy with scoring without having to consult or practice with peers or instructors. In the current investigation, however, pre-service teachers did not practice scoring passages outside of class time. In order to control for amount of time spent in practice, both the technology-enhanced practice group and the in-class practice group practiced scoring ORF during allocated class time and were supervised by the researchers. However, the technology-enhanced practice group did practice independently at separate computers in the lab. Both groups also had access to a researcher in case questions arose. Besides the potential benefit of saving instructional time , the audio clips with technology-enhanced practice also enabled pre-service teachers to hear passages read again in exactly the same way in order to verify reader miscues.

The average number of scoring discrepancies pre-service teachers made at posttest was 4.9 out of 244 possible matches (i.e., correctly read words plus miscues made) yielding 98% accuracy in scoring. In order to help pre-service teachers practice applying the scoring rules, multiple instances of each type of miscue were included in the passage reading. Additionally, pre-service teachers heard relatively fluent reading during practice activities and on dependent measures. When scoring real student readers though, less fluent reading likely would be more commonly exhibited. For example, with slower readers or students with disabilities, a teacher making 5 scoring discrepancies out of a possible 60 matches would lower the scorer's accuracy level to approximately 92%. Therefore, another limitation of the current study relates to generalizability. It is unknown whether pre-service teachers would exhibit the same high level of accuracy when scoring oral reading by actual students of varying ages and abilities who use differing levels of text.

Future Directions

Accuracy in scoring is critical as teachers make greater use of ORF for decision making about student performance and the effectiveness of instruction. Scoring errors are likely to be reduced when teachers administer several passages in one sitting and target the student's median score for decision making, such as the practice typically associated with universal screening measures. However, when ORF is used for weekly or more frequent monitoring, administration usually entails the reading of only one passage with measurement error being reduced by applying decision rules to aggregated scores collected over time. This study focused on the use of ORF as a part of CBM decision making, so examination of scoring accuracy was conducted with only one pre- and posttest measure. Although pre-service teachers developed a high level of scoring accuracy by posttest, future investigations should examine scoring accuracy with more authentic readers of varying age and ability levels, including students with reading disabilities, who may exhibit fewer miscues or read less text than what pre-service teachers heard in the current study. Likewise, text of varying readability levels should be used. Additionally, the feasibility and efficacy of Web-based practice activities should be tested outside of class time.

Although technology has great potential for improving instructional practice, little experimental-contrast research has been conducted to demonstrate its effects on student performance. The current investigation showed that Web-based practice activities designed according to principles of effective instruction enabled pre-service teachers to achieve comparable levels of accuracy in scoring ORF as did the more traditional, in-class practice activities. The potential benefits of using Web-based technology for shortening class time devoted to practice exercises, providing opportunities for pre-service teachers to practice when they want, and extending practice materials to include school-aged children of varying abilities reading authentic texts make a good case for continued development. In the search for research-validated practices, researchers need to make sure that teacher education practices also are effective and achieve desired outcomes.

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Paul J. Riccomini is Assistant Professor and Pamela M. Stecker is Associate Professor in the Eugene T. Moore School of Education at Clemson University. *This research study was funded in part by the Clemson University Innovations Fund. The opinions expressed in this paper are those of the authors and do not necessarily reflect those of the funding agency.* *Address correspondence to Paul J. Riccomini, Clemson University, 416 Tillman Hall, Clemson, SC 29634. Email to: pjr146@clemson.edu.*

The Effect of Active Student Responding during Computer-Assisted Instruction on Social Studies Learning by Students with Learning Disabilities

Annamaria Jerome
Patricia M. Barbetta
Florida International University

An alternating treatments design with a best treatments phase was used to compare two active student response (ASR) conditions and one on-task (OT) condition on the acquisition and maintenance of social studies facts during computer-assisted instruction. Each week for six weeks, five students were provided daily computer-assisted instruction on 21 unknown facts divided randomly into Clicking-ASR (active responses with computer mouse), Repeating-ASR (active oral responses) or Listening-OT (on task or passive responses). For all five students, Repeating-ASR resulted in more facts correct on same-day, next-day, and one-and two-week maintenance tests. During weeks 7 and 8 with implementation of the best treatment condition, Repeating-ASR produced higher scores than all conditions (including Repeating-ASR) during the first 6 weeks.

Technology has established itself as an integral part of special education over the past several decades. With ongoing research on effective practices, technology holds great promise for contributing to the quality of education for students with disabilities. Some see technology as the great equalizer among students with and without disabilities (Roblyer & Edwards, 2000) because its use allows many students with disabilities increased access to the general-education curriculum.

Computer-assisted instruction (CAI), in particular, has potential for playing a critical role in the education of students with disabilities. Computer-assisted instruction can be defined as the use of the computer in the delivery of instruction including presenting new information and providing practice (Newby, Stepich, Lehman, & Russell, 1996). There exists a growing body of literature that documents the benefits of CAI use with students with disabilities (Irish, 2002; Raskind & Higgins, 1998; Smith, 2000). When used properly, CAI can create more opportunities for students to participate in learning, increase academic learning time, meet a wide range of student needs, and motivate student learning (Becker, 1992; Vockell, 1987). Computer-assisted instruction has been shown to yield higher motivation, produce fewer behavior problems, and increase attending behaviors (Chen & Bernard-Opitz, 1993; Ford, Poe, & Cox, 1993; MacArthur, Haynes, & Malouf, 1986; MacArthur, Haynes, Malouf, Harris, & Owings, 1990). Computer-assisted instruction has also been shown to increase academic achievement (e.g., Din, 1996; Koscinski & Gast, 1993; Ota & DuPaul, 2002; Shiah, Mastropieri, Scruggs, & Mushinski-Fulk, 1995). Multimedia-based CAI (i.e., interactive computer program, video captions, and still photographs) has also shown to increase fluency of skills learned (Lancaster, Schumaker, & Deshler, 2002; Mechling & Gast, 2003; Mechling, Gast, & Langone, 2002). Some suggest that CAI is effective when it is used as a supplement to traditional instruction, whereas the effects of CAI as a replacement to traditional instruction are equivocal (Hall, Hughes, & Filbert, 2000). These equivocal results suggest there is still much to be learned about CAI, in particular, the characteristics of effective instructional design.

This study was designed to investigate the role of a*ctive student response* (ASR) in the design of CAI. An active student response is an observable, measurable student response to an instructional antecedent (e.g., responding verbally to a question or a computer prompt, writing a sentence, reading aloud, clicking a mouse to select a response) (Barbetta, Heron, & Heward, 1993). There has been a consistent positive relation between ASR and student learning that comes from large-group correlational studies linking several instructional variables to student achievement (Berliner, 1980; Fischer, Berliner, Filby, Marliave, Cahen, & Dishaw, 1980; Rosenshine & Berliner, 1978) and experimental studies of high-ASR teacher-led and peer-mediated instruction (Barbetta et al., 1993; Barbetta &

Heward, 1993; Drevno, Kimball, Possi, Heward & Barbetta, 1994; Sterling, Barbetta, Heward, & Heron, 1997; Utley, Reddy, Delquadri, & Greenwood, 2001). However, limited research exists that demonstrates empirically the effects of ASR during CAI (e.g., Jerome, Barbetta, Rosenberg, & Brady, 2001; Shin, Deno, Robinson, & Marston, 2000; Tudor, 1995; Tudor & Bostow, 1991; Wilson, Majsterek, & Simmons, 1996).

Tudor and Bostow (1991) and Tudor (1995) evaluated the effects of ASR-CAI with college-level students. In Tudor and Bostow (1991), 75 undergraduate psychology students were randomly assigned to one of five groups who received different types of programmed instruction. Two groups made ASRs by typing their responses on computer frames (with one of the groups receiving feedback) and the other groups made on-task (OT) responses such as passive reading or instructions to think of the correct answers. After completing the programs, students completed a written posttest and developed two programmed instruction frames based on the knowledge they had gained from the program. Results showed that the two ASR groups performed significantly higher in the posttest. Also, they developed programmed instructional frames with higher accuracy than participants in the other groups.

Tudor (1995) conducted a similar study with four college-level students using an alternating treatments design. Text frames were presented one at a time. In one condition, the students filled in the correct responses on the text frames with blanks on it (i.e., an ASR). In the other condition, the students silently read the text frames without blanks on it (i.e., an OT response). Results indicated that students performed better on the items in which they constructed answers on the blank frames. The author concluded that active responding was functionally related to greater achievement.

Shin, Deno, Robinson, and Marston (2000) attempted to predict classroom achievement from ASR during CAI with 48 second graders. In this study, CAI was provided using a computer-based groupware system called Discourse GroupWare Classroom. With this system, the teacher sent instructions from her terminal to each of the students' monitors. Students provided responses to teacher's instructions and the teacher provided feedback to the student. Active student response during the CAI and initial performance were the two independent variables used to predict student's final performance using multiple linear regression analysis. Active responding was found to be a significant predictor and was found to be highly correlated with student final performance, thereby lending further support to the positive effects of ASR during CAI instruction.

A recent study used an alternating treatments design to compare ASR and OT instruction on the acquisition and maintenance of science facts among 4 students with mental retardation during CAI (Jerome et al., 2001) using the hypermedia program, Hyperstudio (Wagner, 1997). During ASR instruction, students were presented a science fact followed by a computer prompt to write the fact on a structured study guide. During OT instruction, students listened to the computer program reading the fact. Students learned science facts in both conditions, however, results from same-day tests show the mean number of ASR facts learned was higher than the mean number of OT facts (4.13 ASR facts and 3.2 OT facts). Individually, the mean number of ASR facts learned was slightly higher for three of the students (1-to-2 more facts scored correctly with ASR compared to OT instruction). Similar results were found on next-day tests. Maintenance tests showed that the group maintained a mean of 73.5 % of the 68 science facts learned in the ASR condition compared to 76.8 % of 56 facts learned with OT instruction. Although the difference was not considerable, the results do lend some credibility to the value of ASR during CAI with students with disabilities. The authors indicated that the narrow performance differences and intervariability may have been due to the study's limitations such as (a) the de-contextualized nature of computer-assisted instruction without any previous or additional content instruction, (b) the difficulty level of the instruction, and (c) a study guide design in which required students to make a limited active response in that they wrote only part of the fact (e.g., often just a word) with the remainder of the fact already completed on the guide.

The present study was designed to extend the results of Jerome et al. (2001) by comparing three types of student responses during CAI on the acquisition and maintenance of social studies facts by students with learning disabilities using the hypermedia program, Hyperstudio (Wagner, 1997). Two of the response conditions required students to make active student responses; *Clicking-ASR* and *Repeating-ASR*. During *Clicking-ASR*, students selected a response by clicking on the mouse. During *Repeating-ASR*, students orally repeated the correct response. The other response condition, *Listening-OT*, required the students to make an on-task response by listening as the fact was read on the computer.

Method

Participants and Setting

Participants were five fifth-grade students with learning disabilities, two females and three males, enrolled in a private school for students with learning disabilities. Parental permission, student consent, and availability during the time of the study were used as selection criteria. Participants were required to have basic computer skills such as using the mouse, and clicking on icons. In addition, participants were required to have a reading level of first grade or above to participate in the study. Full-scale IQ scores based on the *Wechsler's Intelligence Scale for Children* – Third Edition

Table 1.
Participant Characteristics

Student	Age	Gender	IQ			Grade level		
			Full Scale	Verbal	Performance	Spelling	Mathematics	Reading
1	11	M	*	*	*	2.5	3.3	3
2	11	M	76	57	102	1.9	2.3	1.6
3	10	M	126	111	139	2.1	2.9	7.0
4	12	F	*	*	*	2.1	4.0	1.4
5	10	F	109	113	104	2.8	3.8	1.6

Note. The Spelling, Mathematics and Reading grade levels were obtained by the WIAT *(Wechsler's Individual Achievement Test)*. The IQ test scores were obtained from the *Wechsler's Intelligence Scale for Children* - Third Edition (WISC-III). *Information not available.

(WISC-III) ranged from 76 to 109. Reading levels ranged from 1st grade (Student 2) to 7th grade (Student 3) based on the Wechsler's Individual Achievement Test (WIAT).

The study was conducted in an assigned room, referred to as the study room. The same room was used for all the students each day of the study. Each one-to-one CAI practice session and test session occurred in the study room in the school at approximately the same time each day. The length of each session ranged approximately from 20 to 25 minutes per student. The first author served as the researcher.

A Dell personal computer with *Hyperstudio* (Wagner, 1997) was used for the study. Hyperstudio is a hypermedia authoring software program that can incorporate text, sounds, graphics, and animation to create customized lessons according to students needs. The researcher developed the hypermedia social studies lessons that consisted of a series of hypermedia screens. Each hypermedia screen had on it a social studies fact, an *ear icon* and a *next button* icon.

Procedures

General Procedures. For each of the first six weeks of instruction, the 21 unknown facts were randomly assigned to the Clicking-ASR, Repeating-ASR, or Listening-OT conditions using a standard procedure (i.e., 7 per condition). The condition presentation order for each week was determined prior to beginning that week's lesson and was randomly assigned and counterbalanced so that no condition was presented first more than twice a week. The presentation order of the hypermedia cards within each condition was also randomized to keep the students from memorizing facts in order. For the seventh and eighth week, seven unknown facts were identified and assigned only to the condition in which each student performed the best.

On each Monday of the study, the CAI instruction session began with the concept introduction lesson. Following the concept introduction lesson component, the practice sessions began. CAI practice sessions were held four days a week (Mondays through Thursdays) for eight weeks, resulting in 32 practice sessions. Same-day tests took place Mondays through Thursdays directly after the practice sessions. Next-day tests took place Tuesdays through Thursdays immediately prior to the practice sessions and on Fridays prior to the following week's pretest and/or the previous weeks' maintenance test.

Pretest. To develop individualized sets of unknown facts, the researcher pretested each student individually. Pretesting occurred on Fridays and involved the presentation of 30 social studies questions obtained from the two fifth grade social studies textbooks identified by the classroom teacher (Hart, 1999a, 1999b). None of the content from the selected chapters was taught prior to or during the study.

Each student was escorted to the study room individually for pretesting and was seated at a desk across from the researcher. The researcher then proceeded to verbally ask the student social studies questions. Each question was asked twice before the student was permitted to answer. For example, the researcher asked twice, "Who was the first president of the United States?" The student's oral response was recorded verbatim on the pretesting form. For a response to be scored as correct, an accurate oral response had to be made within five seconds. An incorrect response was scored when the student gave an incorrect response or made no response within five seconds. During the first six weeks of the study, the first 21 social studies facts scored as incorrect during each Friday's pretest were included in the next week's CAI.

During weeks seven and eight, each pretest consisted of the presentation of 15 social studies questions using the procedures and criteria for selection identical to those used during the first six weeks.

Concept Introduction Lessons. The concept introduction lesson consisted of a hypermedia screen with lesson background information and an introduction to the lesson for the week. Each student navigated through the lesson independently. Content material for the introduction was presented as text. Each concept introduction screen had an ear icon on it. When the student clicked on the ear icon, the computer orally read the text presented on the screen. The information on the concept introduction screen was related to the social studies facts to be presented during the practice sessions. However, the specific practice session facts (i.e., those to be tested) were not included on the concept introduction screen.

Practice Sessions. The practice sessions began after the concept introduction lesson component. For the first six

Figure 1. Concept Introduction card. This card presented background information prior to practice.

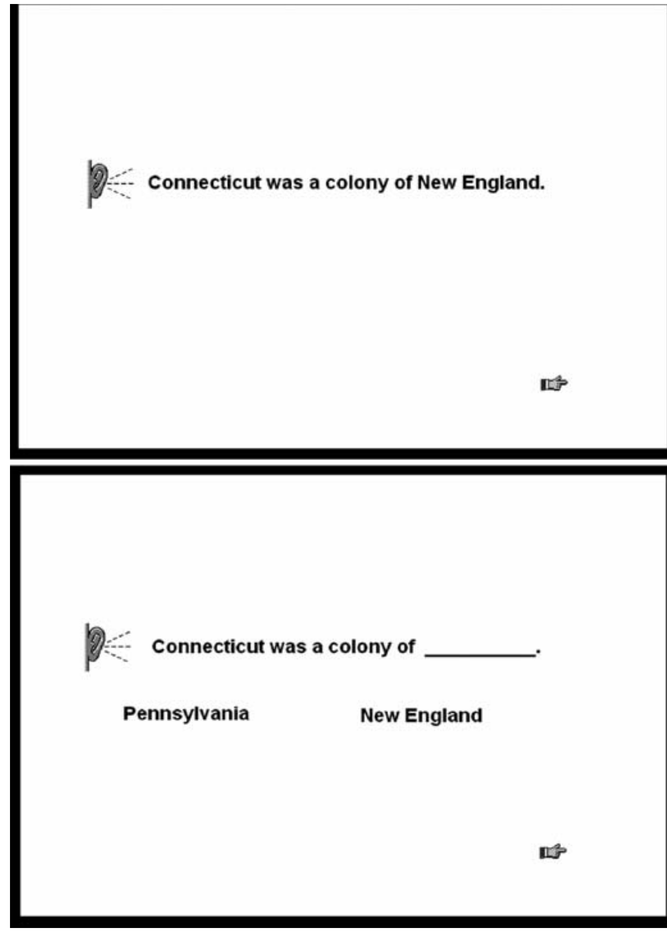
weeks practice consisted of the presentation of 21 unknown facts (i.e., 7 per condition) using one of the three different student response conditions (i.e., either Clicking-ASR, Repeating-ASR, or Listening-OT). A hypermedia screen was presented prior to each condition to indicate to the student what condition was in place. The student progressed through the practice session providing one of the three types of responses. Then he or she progressed to the next screen by clicking on the next button icon. Each condition included seven facts presented twice, providing students with two response opportunities per fact.

After the student completed the seven facts presented twice under the first condition, a prompt was given that the next condition was to be used. The seven facts from the second condition were presented twice in a random fashion, followed by the seven facts from the third condition.

The researcher monitored the students as they progressed through the practice session. When the student reached the last card on the stack, he or she was given stickers on a behavioral chart for cooperative participation and then escorted back to the classroom. At the end of the week, each student was given a small reward (e.g., photo frame, small toy) based on the number of stickers earned.

Conditions. During Clicking-ASR, the student was required to make an active response by clicking on the correct response. The social studies fact was presented in print on a hypermedia screen and was orally read by the computer after the student clicked on the ear icon. The student then moved to the next screen by clicking on the next icon and was directed to click on the correct response. For example, printed on the first screen was "Connecticut was a colony of New England." The student then moved to the next screen with this same fact printed on it in a fill-in-the-blank form with two choices to

Figure 2. Clicking–ASR cards. Required students to click on the right response.

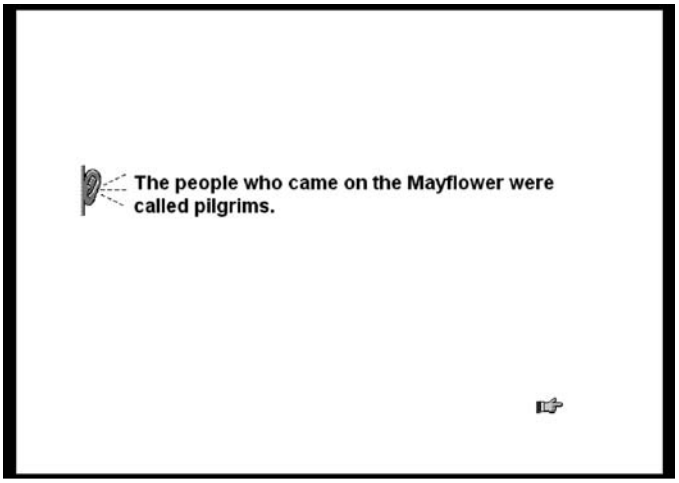


complete the response. In this example, "Connecticut was a colony of __________" was followed by the two choices, " Pennsylvania" and "New England." On this screen, the computer read the fact aloud, and the student then clicked on one of the two responses ("Pennsylvania" or "New England"). If the student clicked on the correct response (in this case "New England"), the computer read it aloud. If the student clicked on the incorrect response, a *breaking glass* sound was produced. The student then moved to the next screen.

During Repeating-ASR, the student made an active response by orally repeating the fact that was presented in print on the card and orally read by the computer. For example, after the student clicked on the ear icon, the computer read, "The people who came on the Mayflower were called pilgrims. Repeat." The student orally repeated the fact. The student then moved to the next card.

During Listening-OT, the student listened to the social studies fact that was printed on the card as it was read aloud

Figure 3. Repeating-ASR card. Required students to repeat the fact being presented.

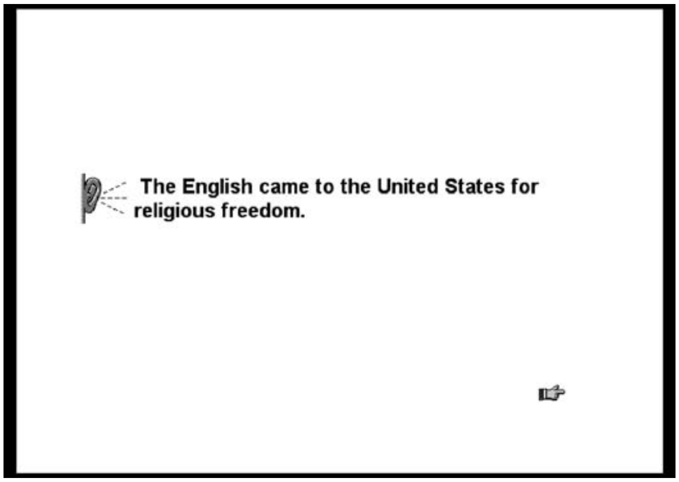


by the computer. The student was then prompted by the computer to listen as it was read again. For example, when the student clicked on the ear icon, the computer read the social studies fact, "The English came to the United States for religious freedom. Listen. The English came to the USA for religious freedom." The student then moved to the next card. During weeks seven and eight, instruction occurred with seven unknown facts using only the best treatment.

Test Sessions. Same-day tests took place Mondays through Thursdays drectly after the practice sessions. Next-day tests took place Tuesdays through Thursdays immediately prior to the practice sessions and on Fridays prior to the following week's pretest and/or the previous weeks' maintenance test.

The researcher orally administered the tests to each student individually. The student sat directly across from the researcher while she read questions two times consecutively for each of the 21 social studies facts. The researcher then waited 5 seconds for the student's response. The response given by the student was written verbatim on the scoring sheet by the researcher. If the student responded correctly within 5 seconds, the item was scored as correct. If the student did not respond within 5 seconds or responded incorrectly, the item was scored as an incorrect response. The researcher then presented the next question. No feedback was provided to the student for correct or incorrect responses.

Figure 4. Listening-ASR card. Required students to listen to the fact being read.



Maintenance tests were conducted 1 and 2 weeks after instruction ended on each set using similar procedures. Only those facts considered learned were included in the maintenance tests. For the purpose of this study, *learned* was defined as those facts stated correctly on the fourth and last day of next-day tests. Two maintenance tests were given for each of the eight sets resulting in eight 1-week and eight 2-week maintenance tests given per student.

Dependent Measures

Data were collected on three major dependent measures: same-day tests, next-day tests, and one and 2-week maintenance tests. The number of correct responses and percentage of correct responses were recorded.

Interobserver Agreement

An independent second observer was trained to score the same-day, next-day, maintenance, and pre-tests according to the criteria presented. The observer was randomly present for observations on 33% of the same and next-day tests and 38% of maintenance tests. Agreements and disagreements between the researcher and the second observer were recorded. The interobserver agreement on same-day, next-day, and maintenance tests for the five students was 100%.

Treatment Integrity

The second observer collected data on treatment integrity to help ensure procedural reliability of the practice and test procedures. The observer was randomly present for observations on 32.5% of the sessions. Data show that all the practice session and test procedures were implemented with 100% accuracy during the observed sessions.

Experimental Design

An alternating treatments design with final best-treatment phase was used to determine the effects of Clicking-ASR, Repeating-ASR, and Listening-OT computer-assisted instruction on the acquisition and maintenance of social studies facts. Each week, seven social studies facts were taught with Clicking-ASR, seven with Repeating-ASR, and seven with Listening-OT. The presentation order of the three conditions was randomized and counterbalanced (no condition was presented first for more than two consecutive sessions) across sessions.

During the last 2 weeks of the study, only the condition determined to be most effective was administered to establish the relative effectiveness of the best condition in isolation and to demonstrate a much stronger functional relation (Tawney & Gast, 1984).

Results

Same-Day Tests

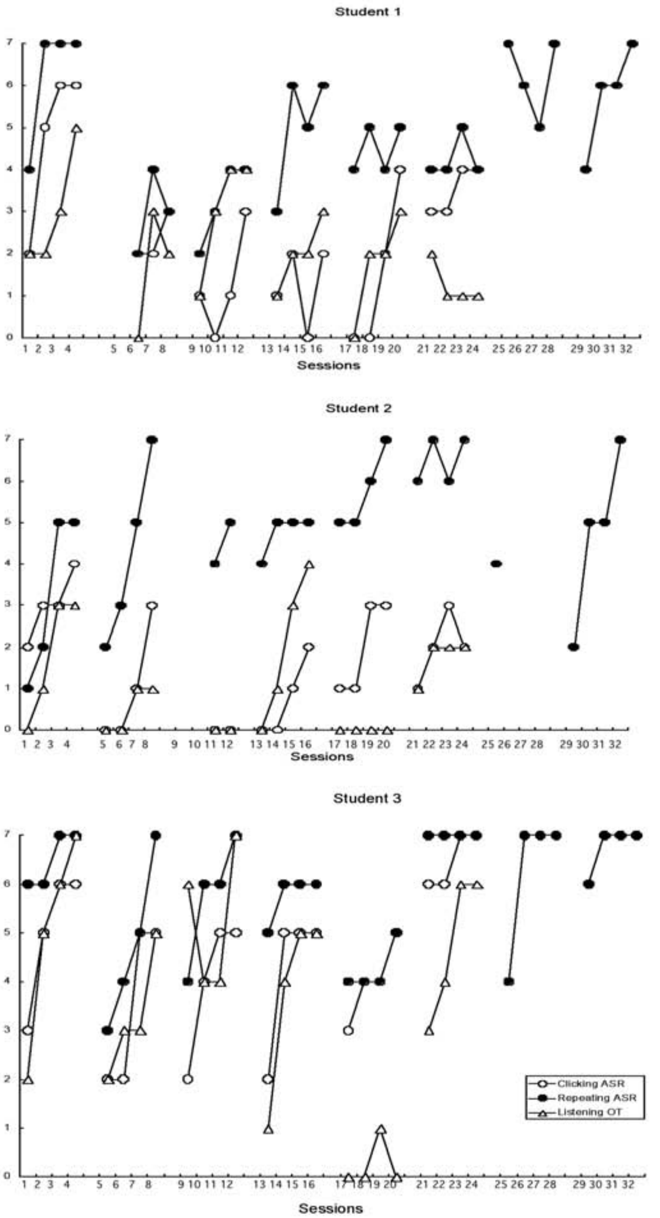
Figures 5 and 6 show each student's performance on same-day tests given immediately after instruction. The mean same-day test scores were highest in the Repeating-ASR condition for all five students on each of the 4 days of instruction individually, as well as across all 4 days (grand mean). For students 2, 3, 4, and 5, mean scores were highest in the Repeating-ASR condition followed by the Clicking-ASR condition on all 4 instructional days, as well as across the four days. Student 2 demonstrated the most considerable performance difference with an average of 3.7 and 4.3 more facts answered correctly on Repeating-ASR fourth day same-day tests than the Clicking-ASR and Listening-OT respectively. Mean scores for Student 1 were highest in the Repeating-ASR condition on all 4 instructional days followed by Listening-OT.

As a group, the mean same-day test scores on each of the 4 successive days of instruction across all sets in the Repeating-ASR condition were 3.9, 5.1, 5.6, 6.0, the mean scores for the Clicking-ASR condition were 1.8, 2.6, 3.3, 4.1, and the mean scores for Listening-OT condition were 1.0, 1.9, 2.8, 3.3.

Of the 124 same-day tests taken by Students 1 through 5, Repeating-ASR same-day test scores were highest on 89 (72%) of the tests, Repeating-ASR results were identical to Clicking-ASR results on 26 (21%) of the tests, and identical to Listening-OT on 5 (4%) of the tests. Scores were highest on three Clicking-ASR same-day tests and one Listening-OT same-day test. In sum, Repeating-ASR instruction resulted in the highest or identical scores on 97% of the same-day tests.

During the seventh and eighth weeks of instruction when only the Repeating-ASR condition (best practice condition) was implemented, Repeating-ASR instruction produced higher scores than all conditions (including Repeating-ASR) during the first 6 weeks of the study.

Figure 5. Number of facts answered correctly on same-day tests (based on 7 facts per condition) given after the practice session for Students 1, 2, and 3. Breaks in data points represent new fact sets.



Next-Day Tests

Figures 7 and 8 show each student's performance on next-day tests given the day after instruction. The mean next-day test scores were highest in the Repeating-ASR condition for all five students on each of the four days of instruction individually, as well as across all 4 days (grand mean). Scores were highest for all the five students in the Repeating-ASR condition followed by the Clicking-ASR and the Listening-OT conditions on all 4 instructional days, as well as across the 4 days. Student 2 demonstrated the most considerable difference with an average of 2.9 and 3.5 more facts answered correctly on Repeating-ASR fourth day next-day tests than the Clicking-ASR and the Listening-OT respectively.

As a group, the mean next-day test scores on each of the 4 successive days of instruction across all sets in the Repeating-ASR condition were 3, 4.5, 4.9, 5.8, the mean

Figure 6. Number of facts answered correctly on same-day tests (based on 7 facts per condition) given after the practice session for Students 4, 5, and the group. Breaks in data points represent new fact sets.

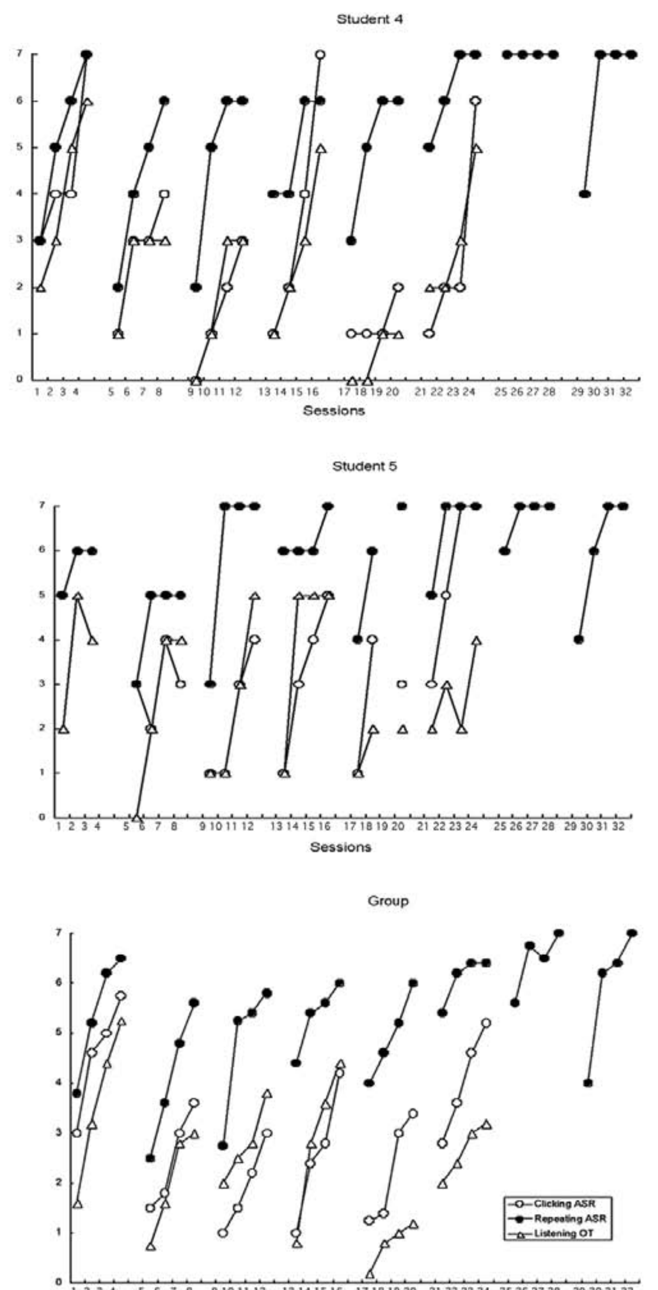
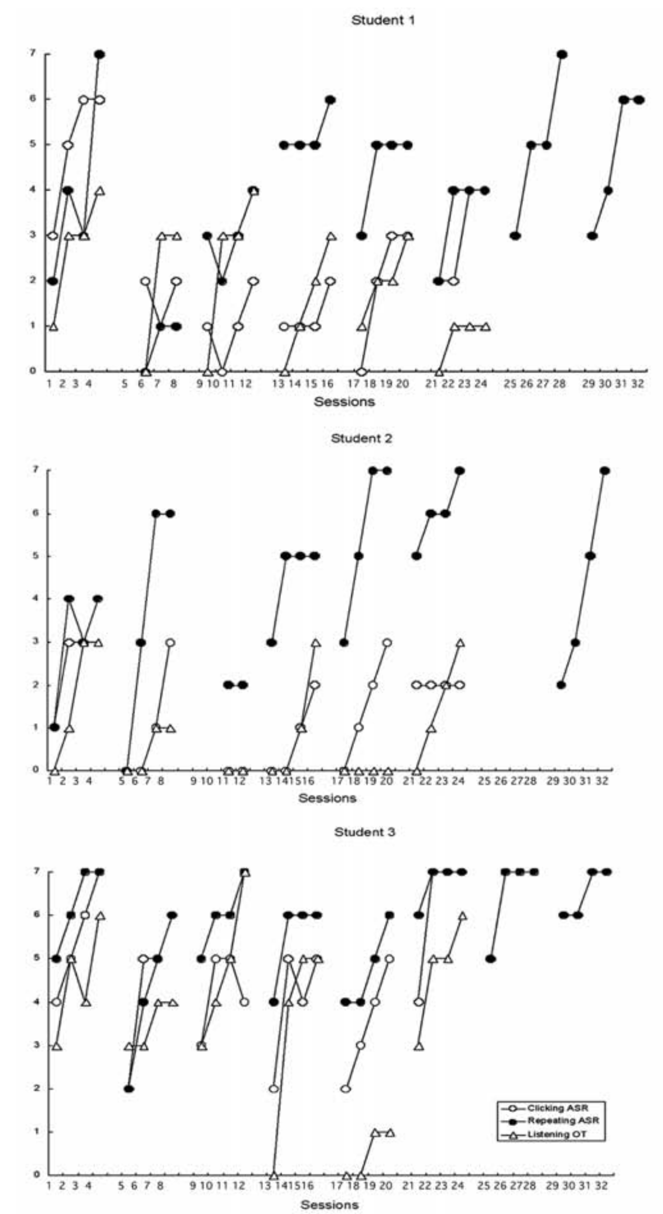


Figure 7. Number of facts answered correctly on next-day tests (based on 7 facts per condition) given prior to each practice sessions for Students 1, 2, and 3. Breaks in data points represent new fact sets.

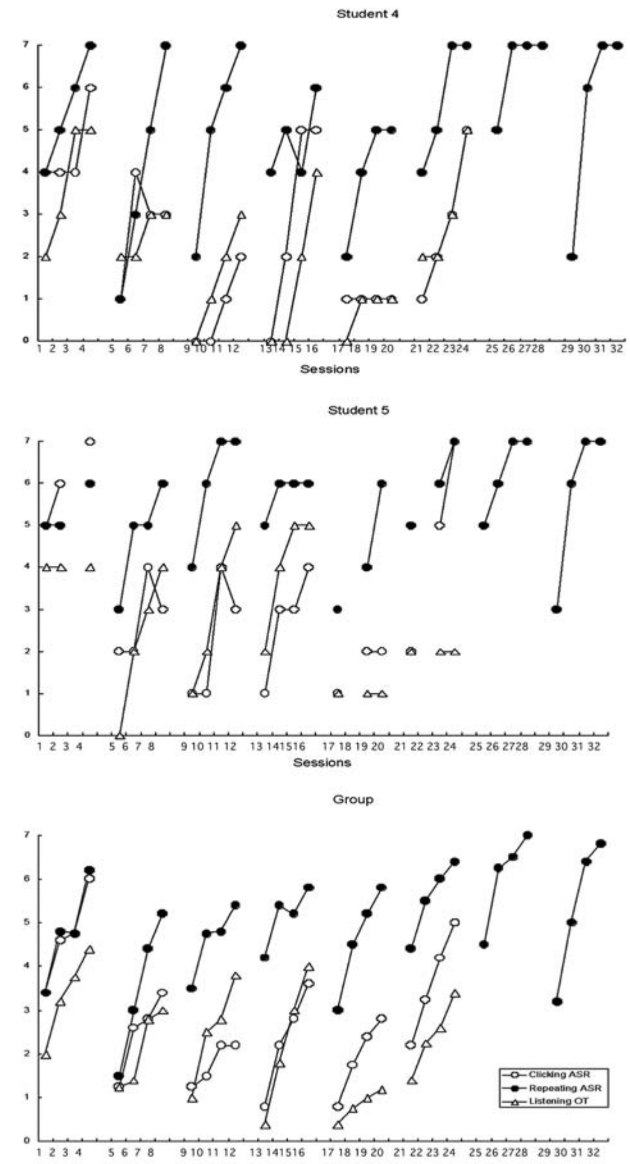


scores for the Clicking-ASR condition were 1.3, 2.1, 2.7, 3.4, and the mean scores for Listening-OT condition were .8, 1.6, 2.4, 3.0.

Of the 124 next-day tests taken by Students 1 through 5, Repeating-ASR next-day test scores were highest on 81 (65%) of the tests, and Repeating-ASR was identical to Clicking-ASR on 14 (11%) and to Listening-OT on 3 (3%) of the tests. Clicking-ASR next-day test scores were highest on nine tests, and Listening-OT next-day test scores were highest on five tests. In sum, Repeating-ASR instruction resulted in the highest or identical scores on 76% of the next-day tests.

During the seventh and eighth weeks of instruction when only the Repeating-ASR condition (best practice condition)

Figure 8. Number of facts answered correctly on next-day tests (based on 7 facts per condition) given prior to each practice sessions for Students 4, 5, and the group. Breaks in data points represent new fact sets.



was implemented, Repeating-ASR instruction produced higher scores than all conditions (including Repeating-ASR) during the first six weeks of the study.

Maintenance Test

Repeating-ASR resulted in more social studies facts correctly answered on tests conducted 1 and 2 weeks after instruction (see Table 2). On 1-week maintenance tests, the Group maintained the highest mean percentage of facts learned in the Repeating-ASR condition (91.6%), followed by the Clicking-ASR (79.4%) and the Listening-OT (75.1%) conditions. Two-week maintenance tests also showed that the Group maintained a highest percentage of facts in the Repeating-ASR condition (93.2%), followed by the Clicking-ASR condition (82.2%) and the Listening-OT condition (74.3%).

Discussion

Students learned and maintained more social studies facts taught with Repeating-ASR followed by Clicking-ASR and Listening-OT. This study lends further support to the research demonstrating the positive relation between active student responding (ASR) and student achievement (e.g., Barbetta et al., 1993; Brophy, 1987; Sterling et al., 1997). This study focused on the effects of ASR during CAI. Thereby adding a dimension to the ASR literature that has focused primarily on the effects of increased ASR during teacher-led or peer mediated instruction. A limited number of studies exist that directly investigated the effects of ASR during CAI (e.g., Jerome, et al., 2001; Shin, Deno, Robinson, & Marston, 2000; Tudor, 1995; Tudor & Bostow, 1991; Wilson, Majsterek, & Simmons, 1996) and only one of these studies (Jerome, et al., 2001) was conducted was with students with disabilities.

This study extended the findings of Jerome et al. (2001) in which a written active student response was found to be slightly more effective than a listening on-task response during CAI for students with mental retardation. Although most students learned more in the ASR condition in Jerome et al. (2001), the authors suggested that the study's curricular limitations (e.g., lack of background knowledge, curricular content that was too difficult, design of the study guide) resulted in limited evidence of differential effects. In this study, different ASR conditions were used and background knowledge was provided through the concept introduction lesson components.

Existing CAI literature generally supports the use of technology in the delivery of instruction for both general and special education students. However, empirical evidence of its effectiveness is only beginning to emerge (Hitchcock & Noonan, 2000; Jimenez, Oritz, Rodrigo, & Hernandez-Valle, 2003; Mastropieri, Scruggs, & Shiah, 1997) and much remains to be learned about the characteristics of effective CAI instruction. This study provided empirical evidence of a functional relation between ASR and student achievement during CAI, as with other types of instruction (e.g., teacher-led, peer mediated). Further, this study suggests that one type of ASR (an oral repeating response) can be more effective than the more traditional clicking response that is required of most CAI.

The results have several implications for classroom practice. To improve the effectiveness of instruction, teachers

Table 2.
Mean Number and Range of Facts Answered Correctly on Fourth Day Next-Day Tests, and One and Two-Week Maintenance Tests.

	Clicking			Repeating			Listening		
Student	4th Next – Day Test	1-Wk MT	2-Wk MT	4th Next – Day Test	1-Wk MT	2-Wk MT	4th Next – Day Test	1-Wk MT	2-Wk MT
1	3.2	2.3	2.5	5	4.2	4.5	3	2.6	2.5
		63.9%	72.2%		86.6%	90.9%		90.3%	84.7%
	(2-6)	(0-6)	(0-6)	(1-7)	(1-7)	(1-7)	(1-4)	(1-4)	(1-4)
2	2.3	1.8	1.8	5.4	4.8	4.8	1.7	1.2	1
		63.9%	63.9%		86.7%	86.7%		38.9%	33.4%
	(0-4)	(0-4)	(0-4)	(2-7)	(1-7)	(1-7)	(0-3)	(0-3)	(0-2)
3	5.7	5.3	5.7	6.6	6.5	6.6	4.8	4.7	4.7
		94.3%	100%		97.9%	100%		83.3%	83.3%
	(4-7)	(4-7)	(4-7)	(6-7)	(5-7)	(6-7)	(1-7)	(0-7)	(0-7)
4	3.7	3.3	3.3	6.6	6.1	6	3.7	2.8	3.2
		93.9%	88.3%		92.3%	90.5%		81.4%	90.3%
	(1-6)	(1-5)	(1-6)	(5-7)	(4-7)	(4-7)	(1-6)	(1-4)	(1-5)
5	5	4	4.2	6.5	6.1	6.4	3.8	3	3
		80.9%	86.5%		94.3%	97.9%		81.7%	80%
	(3-7)	(2-7)	(2-7)	(6-7)	(5-7)	(5-7)	(1-5)	(1-5)	(1-5)
Total	19.9	16.7	17.5	30.1	27.7	28.3	17	14.3	14.4
Mean	3.9	3.3	3.5	6	5.5	5.7	3.4	2.9	2.9
%		79.4%	82.2%		91.6%	93.2%		75.1%	74.3%
Range	(0-7)	(0-7)	(0-7)	(1-7)	(1-7)	(1-7)	(0-7)	(0-7)	(0-7)

Note. *The top numbers indicate mean performance. The percentage figures indicate the percent of facts maintained on one-and two-week maintenance tests. The numbers in parentheses indicate range of performance.*

should select or design CAI that promotes high rates of ASR rather than those that require only passive attention or on-task performances from their students. Further, the type of ASR required is critical. Teachers should require students to make an oral response during CAI rather than simply a clicking response. Most commercially-developed CAI instruction, however, does not require students to make an oral response similar to the one used in the Repeating-ASR condition. Although preliminary, these results suggest that teachers should add an oral component to their CAI assignments. Students could be required to say the critical information (e.g., facts, numbers, concepts, names) as they select or click with the computer mouse. CAI that includes whole group active student responding should be considered for instruction. Information and questions could be presented using the computer and an LCD projector or TV connection. Students could actively respond by chorally responding (i.e., responding in unison) and occasionally responding individually. Students who miss a teacher-led CAI lesson could review the lesson independently at the computer at a later time.

Parents should be made aware of the importance of ASR while choosing educational software for their children. First and foremost, a parent should purchase software that requires their child to be actively engaged in the lesson. When their child uses the instructional software, he or she should be encouraged to make oral active responses in addition to the required clicking responses. Also, special education university faculty should emphasize and demonstrate the importance of ASR based CAI in the training of future teachers.

Rigorous research methodologies were used to control for the study's internal validity which gave confidence to the results and set the groundwork for future research. However, the results of this study are preliminary and should be viewed as such. In addition, the nature of single-subject design research limits the generalization of findings. Generalization of the findings must be established through direct and systematic experimental replication which can be accomplished in multiple ways. For example in this study, social studies was the subject area and the participants were students with learning disabilities. A similar study could be replicated among students with other disabilities, typical learners, students of other ages, and across other curricular areas. Future research might include modifying various methodological variables, such as the number of facts per condition, and modifying the design of the hypermedia cards.

More comprehensive use of the components of hypermedia instruction (e.g., sound, animation, video-segments, and non-linear progression) should be included in future research.

Much more research is needed to identify other characteristics of effective computer assisted instruction including, presentation style, screen design, interaction and feedback, ease of navigation, learner control, and use of multimedia features such as color, graphics, animation, audio and video (Roblyer & Edwards, 2000). Also future research should investigate the effects of ASR-CAI on higher-order thinking skills such as drawing inferences or synthesizing information rather than basic recognition or recall responses as was the case in the present study. In this study, the opportunity for students to make an ASR or OT response immediately followed the presentation of the concept to be practiced. Further research is needed to determine if each condition's effectiveness would differ if the opportunity to make an active student response occurred after the presentation of all the facts rather than immediately after each fact was presented. The implementation of these study variations would add considerably to the knowledge of effective computer-assisted instruction.

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Annamaria Jerome is visiting Professor in the Department of Educational and Psychological Studies at Florida International University. Patricia Barbetta is Associate Professor in the Department of Educational and Psychological Studies at Florida International University. Address correspondence to Annamaria Jerome, Florida International University, Department of Educational and Psychological Studies, ZEB 212, 11200 SW 8th Street, Miami, FL, 33199. Email to: jeromea@fiu.edu.

Distance Education: An Exploration of Alternative Methods and Types of Instructional Media in Teacher Education

Ashley Ann Skylar
California State University, Northridge
Kyle Higgins
Randall Boone
Paul Jones
Tom Pierce
Jeff Gelfer
University of Nevada Las Vegas

Universities currently are exploring an array of instructional media to facilitate the delivery of instruction. Consensus from the studies indicates that there is no significant difference in the achievement of students who participate in traditional or online coursework. However, little research has compared traditional learning with the new multimedia online technologies that are becoming more prevalent in distance education.

This study investigated the achievement, student satisfaction, and instructor course evaluations of pre-service general education students who participated in three special education courses in which a variety of instructional media and methods were used. The media used were: (a) a traditional classroom, (b) an online classroom (WebCT), and a (c) class-in-a-box via multimedia CD-ROMs. The various methods used to deliver the instructional content included PowerPoint notes, lecture notes, digital videos, and the textbook. Results of the study revealed that there were no significant differences found between the achievement of the students and the three conditions (e.g., traditional classroom, the online classroom, or the class-in-a-box via multimedia CD-ROMs). Also, no significant differences were found in the student satisfaction of the three groups. All were satisfied with the type of media of instruction in which they participated. Finally, the instructor course evaluation results completed by the three groups were not significantly different, indicating that the three groups evaluated the instructor and the instructional media similarly. The implications of these results for delivering courses via distance education are discussed.

Distance education, using a variety of instructional media and methods (e.g., correspondence courses, broadcasting courses via radio and television, interactive television, and online learning) has been used since the late 19th century. This type of education has eliminated the need to travel to on-site locations, which has been important for students in rural areas, students with employment restrictions, and students with physical limitations. With the advent of new technologies, universities are beginning to focus on a variety of technological innovations to provide Web-based distance education (Khan, 1997).

Online learning environments are becoming more prevalent in teacher education. Currently, instructors are attempting to emulate traditional instructional methods in the online learning environment as much as possible (Navarro & Shoemaker, 2000). The use of audio and video to provide authentic learning experiences for learners who participate in a variety of distance education situations (e.g., multimedia CD-ROM lectures, WebCT) is increasing. Instructors use these types of instructional media to enhance a traditional course, create a hybrid course (combination of online and traditional), or develop a stand-alone online course (Carchidi, 2002). Numerous studies have compared the academic performance of distance learners to that of traditional learners (Baker, Hale, & Gifford, 1997; Diaz, 2000; Navarro & Shoemaker, 2000; Paulsen, 1997; Whitworth, 1999). Consensus from the studies indicates that there is no significant difference in the achievement of student participants in traditional or online coursework.

Recent studies appear to indicate that students enrolled in online courses are as satisfied or more satisfied than students in a traditional course (Diaz, 2000; Thurmond, Wambach, Conners, & Frey, 2002). The variables identified that impact student satisfaction with online courses are: (a) timely comments from the instructor, (b) a variety of methods to assess student work, and (c) social interaction in the online environment (Gunawardena & Zittle, 1997; Thurmond et al., 2002). Research also suggests that online instructional techniques (e.g., collaborative online discussions, online quizzes/tests, interactive assignments that use the World Wide Web) combined with appropriate instructional design of the online course impact student achievement and student satisfaction (Chyung, 2001; Gunawardena & Zittle, 1997; Schutte, 1998; Smith, Smith, & Boone, 2000). Various online features that have been used to increase interaction in online courses include asynchronous communication tools (e.g., threaded discussion board) and synchronous communication tools (e.g., chat room).

Problem

In multimedia CD-ROM instruction, students view objects, realistic scenes, and perspectives that are difficult or impossible to observe in real life (Navarro & Shoemaker, 2000). Typically, multimedia CD-ROM instruction is a stand-alone course in which instruction is contained on a CD-ROM and students progress through the course/content at their own pace (Inglis, Ling, & Joosten, 1999). This type of instruction offers the potential to serve large numbers of students who live in remote areas with limited online access. Barron and Baumbach (1990) concluded that multimedia CD-ROMs are a cost efficient and effective type of instructional media to train a large number of people.

While research concerning multimedia CD-ROMs as a form of distance education is in its infancy, researchers have begun to conduct studies to evaluate student achievement and student satisfaction with this type of instructional media (Navarro & Shoemaker, 2000; Barron & Baumbach, 1990; Bliss & Mazur, 1996; Liaupsin, 2002). For example, Navarro and Shoemaker (2000) conducted a study using CD-ROMs as an alternative to traditional instruction. They found that the CD-ROM group performed significantly better on the final exam than the students in the traditional group. Navarro and Shoemaker (2000) concluded that the incorporation of well-designed multimedia CD-ROM lectures is an acceptable substitute for traditional classroom lectures.

In another study using CD-ROM case studies, results indicated that students were motivated to solve problems presented to them via multimedia CD-ROMs (Ochoa et al., 2001). Ochoa et al. concluded that multimedia components (e.g., video and audio) and the interactivity of a CD-ROM module was a viable media of instruction (2001). However, research also has concluded that instructors must consider the technological barriers students may encounter when participating in a multimedia CD-ROM course (Liaupsin, 2002).

Few studies have compared traditional learning with the newer, multimedia online technologies (e.g., digital video, multimedia CD-ROMs) that are emerging as educational entities in distance education today (Navarro & Shoemaker, 2000; Liaupsin, 2002; Barron & Baumbach, 1990). The literature suggests that more comprehensive research is needed using newer multimedia technology. Through the evaluation of the types of instructional media and/or methods used in distance education, instructors can continually adapt, modify, and improve the access and quality of the education provided.

Purpose of the Study

The purpose of this study was to compare student achievement, student satisfaction, and instructor evaluations of a special education course in which students participated in three types of instructional media (e.g., traditional classroom, online classroom, and class-in-a-box via multimedia CD-ROMs). The study asked the following five questions.

1. Does the type of instructional media have a differential effect on the academic performance of students receiving instruction in the three conditions?
2. For test items based on content presented only in the textbook, are there differences in performance among the three conditions?
3. For test items based on content presented in lecture, PowerPoint notes, digital video, and the textbook, are there differences in performance among the three conditions?
4. Does the type of instructional media have a differential effect on the course satisfaction of students receiving instruction in the three conditions?
5. Does the type of instructional media have a differential effect on the course evaluations of the instructor completed by the students receiving instruction in the three conditions?

Method

Participants

Seventy-six pre-service general education students who were enrolled in an introductory special education course participated in this study. The course centered on an overview of disabilities, collaboration and inclusion models, and strategies for adapting and modifying general education curricula/materials for students with special needs. Thirty pre-service general education students enrolled in the traditional section in the fall of 2003, and 46 pre-service general education students enrolled in the distance education section

Table 1.
Student Demographics

Characteristics	Fall 2003 Traditional n=30	Spring 2004 WebCT-Online n=25	Spring 2004 Class in a Box n=21
Gender			
Male	6	4	3
Female	24	21	18
Age			
Mean	24.7	25.2	25.4
Range	19-52	20-37	20-37
Major			
Elementary	15	12	13
Secondary	13	12	6
Other	2	1	2

of the course in the spring of 2004 (see Table 1). The students in the distance education section were assigned randomly into two groups: (a) the online via WebCT section, and (b) the class-in-a-box CD-ROM section. Of the 76 students in this study, 63 (83%) were female and 13 (17%) were male. Of this population, 40 students indicated they were elementary education majors, 31 indicated they were secondary education majors, and 5 were undecided. The average age of all the students was 25. The youngest student was 19 and the oldest student was 51.

Setting

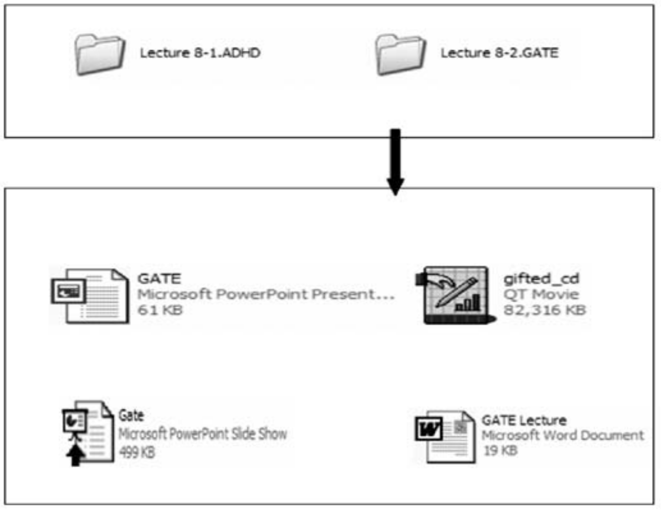
Three settings were used for this study. The first setting, the traditional classroom, occurred in the fall of 2003. The online section and the class-in-a-box section took place in the spring of 2004.

Traditional classroom. The traditional classroom environment for this study was located in a classroom on campus at a western university. The room contained an overhead projector, a computer, and one wall of white boards. Students needed to be present in class to access the instructional content for the course, hand in assignments, and take quizzes and exams.

Online classroom. The online version of the course was taught via WebCT. The online course included the course syllabus, instruction via PowerPoint notes, verbatim transcribed lecture notes used in the traditional course from the fall of 2003, eighteen digital videos (e.g., high and low incidence disabilities, law, inclusion), an assignment drop box, and access to an online discussion forum that was used to communicate with class peers and the instructor. In this environment, the students did not need to be present in order to access and receive instruction. However, they did need to adhere to due dates for taking weekly quizzes, exams, and turning in assignments.

Class-in-a-box. The learning environment created for this study was the class-in-a-box. This was instruction in a take-home study format contained on three CD-ROMs. At the beginning of the semester, the students received three CD-ROMs containing all course instructional content (e.g., PowerPoint notes, verbatim transcribed lecture notes from the traditional course from the fall of 2003, and 18 digital videos). The content on each CD-ROM was organized in folders describing the topic and lecture number (e.g., Learning Disabilities, Lecture 3) (see Figure 1). Students in this group needed to access the online environment to take quizzes and to communicate with the instructor. They did not have to adhere to due dates for accessing content, taking quizzes and exams, and turning in assignments.

Figure 1. Sample of the instructional files contained on the CD-ROMs.



Instruments

The instruments used in this study included a pretest, posttest, student satisfaction survey, and the Department of Special Education form for the evaluation of the instructor used at the university. These instruments were administered during the fall of 2003 and the spring of 2004.

Pretest. A 42-item pretest covering material contained in the course was administered to the students enrolled in the three sections of the course. The 42-item multiple-choice and true-and-false test was taken from the test bank that corresponds to the course textbook, *The Inclusive Classroom: Strategies for Effective Instruction* (Mastropieri & Scruggs, 2004) as well as from course lectures and videos.

Out of the 42 test questions, 21 were identified as textbook questions and were not covered in the lectures, notes, or digital videos. The remaining 21 questions were identified as being covered in the textbook, as well as in the lectures, PowerPoint notes, and digital videos.

Posttest. The students were administered a 98-item posttest to determine the amount of knowledge gained throughout the semester. The posttest consisted of multiple-choice, true and false, and matching questions. The posttest was comprised of 49 test questions dealing with material covered only in the textbook and not reinforced in any other instruction in the course. An additional 49 test questions were selected from material that was in the text and also presented in lectures, PowerPoint notes, and digital videos.

Student satisfaction surveys. Student satisfaction surveys concerning the media of instruction (e.g., traditional, online, or class-in-a-box) were used in the three classes and completed by each pre-service student at the end of the semester. The survey focused on student satisfaction with the media of instruction and the method for presenting the instructional content (e.g., PowerPoint notes, lecture/transcribed lecture notes via text documents, and digital videos). The survey also covered willingness to take another course via the same instructional media and the effectiveness of the instructional media and method in meeting course objectives.

Instructor course evaluations. The instructor course evaluation form used by the Department of Special Education at the university was completed by all students at the end of the course. The evaluation was used to ascertain student satisfaction concerning the course and the instructor's ability to deliver the course content. The evaluation was based on a 5-point Likert scale and contained questions focusing on: (a) presentation of the goals and purposes, (b) command of the subject matter, (c) presentation of course material, (d) evaluation methods, (e) opportunities to increase knowledge of the subject, and (f) overall performance in this course.

Design and Procedures

This study was conducted in four phases. Phase One consisted of instruction of the traditional classroom in the fall of 2003. The second phase occurred simultaneously with phase one and consisted of the preparation of the online classroom and the class-in-a-box via multimedia CD-ROMs. The third phase consisted of the instruction of the online classroom and the class-in-a-box in the spring of 2004. The last phase consisted of the analysis and interpretation of the results.

Phase One

Thirty students who were enrolled in an on-campus section of an introductory special education course participated in the study in the fall of 2003. The students provided demographic information and completed the 42-item pretest during the first class session. The pretest was given to determine student level of knowledge prior to instruction. The students attended a 2 hour and 30 minute weekly lecture for 15 weeks. Each lecture began with 30 minutes of organizational business that included previewing previously learned material and completion of the weekly quiz. New content was presented for approximately 2 hours. Each class lecture was audio-recorded to be used in the preparation of the online and class-in-a-box sections. Students in the traditional on campus section had weekly access to the instructor and they also communicated with the instructor through email. During final exam week, the traditional course students completed the student satisfaction survey, evaluation of the instructor, and the posttest.

Phase Two

Phase Two occurred simultaneously with Phase One during the fall semester of 2003. This phase included the preparation of the online WebCT class and the class-in-a-box via multimedia CD-ROMs.

Preparation for the online class. Following each traditional class lecture, the audio cassettes were transcribed verbatim into word-processing documents so that the exact information could be used in the development of the online course and class-in-a-box. Next, the lecture text documents, digital videos, and related course materials (e.g., PowerPoint notes, syllabus, etc.) were loaded on the WebCT server for the online class. The quizzes were constructed and loaded on the WebCT server for this group. The sequence of the instructional content and the material presented was identical to the traditional classroom.

Preparation for the class-in-a-box. The exact material loaded on the WebCT server for the online class (e.g., PowerPoint notes, digital videos, and transcribed lecture notes) was burned onto CD-ROMs for the class-in-a-box course. Thirty sets of multimedia CD-ROMs were prepared. All of the course content fit on three CD-ROMs. Each CD-ROM was labeled with the topics and lecture numbers (see Figures 1 & 2). The sequence of the instructional content and the material presented was identical to the traditional classroom and the online WebCT section. The quizzes were constructed and loaded on the WebCT server for this group. The quizzes and email communication with the instructor were the only online components for this group.

Phase Three

Phase three included the instruction of the online class and the multimedia CD-ROM class. This phase took place during the spring of 2004. Students attended class on campus the first and last class session. The other class sessions students worked off campus wherever they had online access (online class) or access to a computer (class-in-a-box).

Online class. Twenty-five students were randomly assigned to the online section of the course. During the first class session, students received basic instruction regarding using WebCT. The training included how to: (a) access the WebCT site, (b) access course content, (c) turn in assignments, (d) access weekly quizzes, and (e) communicate with the instructor and other students. Students also completed demographic information and a pretest to determine their knowledge level prior to instruction.

Throughout the 16-week semester, students in the online class accessed the instructional content via WebCT. The students downloaded and printed out notes as well as viewed digital videos. The students in this section adhered to the due dates on the syllabus for assignments and weekly quizzes. Students met on campus the last class session to complete the posttest, student satisfaction survey, and instructor course evaluation.

Class-in-a-box. Twenty-one students were randomly assigned to the class-in-a-box section of the course. The students attended the first class session on campus in order to receive the CD-ROMs that contained content for the course. Students received basic instruction on the organization of the course content on each CD-ROM. They also were instructed on how to download *Quick Time Player* 6.3 (Apple Computer, 2003) in order to view the digital movies contained in the lectures and how to download the lecture notes.

Students in this group had the entire semester to complete the course content without any timeframes for accessing instructional content, taking quizzes, or turning in assignments. However, the students were required to take the quizzes sequentially (e.g. Quiz 1, Quiz 2). Quizzes were taken online using WebCT. Students who completed course assignments and weekly quizzes prior to exam week had the option of taking the posttest in order to complete the course early. Students who took the entire semester to complete the course came to the university to take the posttest during final exam week. They also administered the student satisfaction survey and instructor course evaluation.

Phase Four

Data from the pretest and posttest were collected and scored by machine. Twenty-five percent of the pretests and posttests were selected randomly and rescored by the researcher to ensure scoring reliability. Data were then entered into a spreadsheet and analyzed using Statistical Package for Social Sciences (SPSS). Pretest and posttest data collected were analyzed using an analysis of covariance (ANCOVA). The independent variable in this study was the media of instruction (e.g., traditional, online, class-in-a-box). The dependent variable in this study was the posttest scores and the pretest scores were used as a covariant to correct for pre-existing differences. Data from the student satisfaction surveys and the instructor course evaluations were analyzed using an analysis of variance (ANOVA). The mean and standard deviations were compared across test, surveys, and instructor course evaluations for each group. Results are reported in Tables 1-10.

Results

In this study, 30 students enrolled in the traditional classroom (control group) setting in the fall of 2003. In the spring of 2004, 46 students enrolled in a distance education section of the same course. These students were randomly assigned to one of two instructional media (online, class-in-a-box). These students were the experimental groups in the study. Data were collected in the form of pretests, posttests, student satisfaction surveys, and instructor course evaluations.

Knowledge-Based Tests

A knowledge-based pretest (42-items) was given to all students at the beginning of the study. Following completion of the course, a knowledge-based posttest (98-items) was administered to all students to ascertain if there was a significant difference in test scores between the groups from the beginning to the end of the semester. These test scores were analyzed using an analysis of covariance (ANCOVA). This analysis was selected to control for prior knowledge using the pretest as the covariate.

Research Question One dealt with the differential effect of the media of instruction on student academic performance. The mean and standard deviations are reported in Table 2. Results from the ANCOVA indicated that there were no statistically significant differences between pretest and posttest scores of the students instructed by the three different types of instructional media [$F(2,72) = 2.197$, $p = .119$] (see Table 3). The results of this analysis suggested that all three types of instructional media were equally effective in delivering instructional content to the students. Although differences were not statistically significant, the mean scores (see Table 2) were not identical. The pretest mean scores of the students indicated that students receiving instruction in the class-in-a-box had the lowest test scores (17.24) and on the posttest they had the highest scores (81.43) (see Table 2).

Research Question Two focused on content presented only in the textbook and the differences in the academic

Table 2.
Summary of Means and Standard Deviations for the Pretest and Posttest

	Pretest			Posttest		
Media of Instruction	n	SD	Mean	n	SD	Mean
Traditional	30	3.43	18.87	30	8.394	76.47
Online via WebCT	25	3.10	18.88	25	12.595	79.04
Class-in-a-Box	21	2.39	17.24	21	10.875	81.43

Table 3.
Summary of Analysis of Covariance (ANCOVA) Between Groups on Posttest with Pretest as the Covariate

Source	DF	SS	MS	F	p
Covariate	1	481.758	481.758	4.485	.038
Between Groups	2	472.022	263.011	2.197	.119
Error	72	7733.812			
Corrected Total	75	8524.421			

Note. **p*<.05 level

performance among the three instructional groups. Table 4 summarizes descriptive statistics for pretest and posttest items that were presented only in the textbook. Results from the ANCOVA indicated that there was no statistically significant effect for test items based on content presented only in the textbook between posttest scores of the students instructed by the three different types of instructional media [F (2,72) = 2.447, p = .094] (see Table 5). The results of this analysis suggested that all of the types of instructional media were equally effective for test items from the textbook.

Table 4.
Summary of Means and Standard Deviations for the Pretest and Posttest Items Presented only in the Textbook

	Pretest			Posttest		
Media of Instruction	n	SD	Mean	n	SD	Mean
Traditional	30	2.05	8.13	30	4.467	37.67
Online via WebCT	25	2.09	8.72	25	7.182	38.60
Class-in-a-Box	21	1.74	7.33	21	5.325	40.86

Table 5.
Summary of Analysis of Covariance (ANCOVA) Between Groups on Selected Posttest Items only Presented in the Textbook with Pretest as the Covariate

Source	DF	SS	MS	F	p
Covariate	1	55.753	55.753	1.725	.193
Between Groups	2	158.210	79.105	2.447	.094
Error	72	117251.000			
Corrected Total	75	2511.408			

Note. **p*<.05 level

Research Question Three dealt with content presented in lectures, PowerPoint notes, digital videos, and the textbook and the differences in the academic performance among the three instructional groups. Table 6 summarizes the descriptive statistics. The data indicated no statistically significant differences for test items based on content presented in lectures, PowerPoint notes, digital videos and the textbook between the pretest and posttest scores of the students instructed by the three different types of instructional media [F (2,72) = 1.227, p = .299] (see Table 7). The results of this analysis suggested that all three types of instructional media were equally effective for test items presented in lectures, PowerPoint notes, digital videos, and the textbook.

Table 6.
Summary of Means and Standard Deviations for the Selected Pretest and Posttest Items Presented in Lecture, PowerPoint notes, Digital Video, and the Textbook

	Pretest			Posttest		
Media of Instruction	n	SD	Mean	n	SD	Mean
Traditional	30	2.41	10.73	30	4.439	38.77
Online via WebCT	25	2.32	10.16	25	5.670	40.36
Class-in-a-Box	21	1.79	9.90	21	6.055	40.57

Table 7.
Summary of Analysis of Covariance (ANCOVA) Between Groups on Selected Posttest Items Presented in Lecture, PowerPoint notes, Digital Video, and the Textbook with Pretest as the Covariate

Source	DF	SS	MS	F	p
Covariate	1	54.161	54.161	1.928	.169
Between Groups	2	68.900	34.450	1.227	.299
Error	72	2022.108	28.085		
Total	75	2128.632			

Note. **p*<.05 level

Student Satisfaction Surveys

Research Question Four dealt with the satisfaction of the students concerning the media of instruction in which they participated. The means for the three groups were: (a) the traditional group mean was 73.63; (b) the online group mean was 68.24; and (c) the class-in-a-box group mean was 71.14 (see Table 8). Results from the ANOVA indicated that there was no statistically significant effect between student satisfaction with the course and the three different types of instructional media [F (2,73) = 1.492, p = .232] (see Table 9).

Instructor Course Evaluations

Research Question Five focused on the impact of the media of instruction on the instructor course evaluations

Table 8.
Summary of Means and Standard Deviations for the Student Satisfaction Surveys

Media of Instruction	n	SD	Mean
Traditional	30	9.91	73.63
Online via WebCT	25	13.56	68.24
Class-in-a-Box	21	11.06	71.14

Table 9.
Summary of Analysis of Variance (ANOVA) Between Groups for the Student Satisfaction Surveys

Source	DF	SS	MS	F	p
Between Groups	2	396.678	198.339	1.492	.232
Error	73	9706.098			
Total	75	10102.776			

Note. *p<.05 level

completed by the students who received instruction in the traditional classroom, the online classroom, or the class-in-a-box. Descriptive statistics indicated that the traditional classroom (26.04) rated the instructor and course higher than the students in the online class (24.76) and the students in the class-in-a-box (23.95) (see Table 10). Results form ANOVA indicated that there was no statistically significant effect between the three types of instructional media and the students' evaluations of the instructor and the course [F (2, 66) = 1.142, p = .325] (see Table 11). All three groups were satisfied with the instructor and the structure of the course in which they participated.

Table 10.
Summary of Means and Standard Deviations for the Student Satisfaction Surveys

Media of Instruction	n	SD	Mean
Traditional	30	5.36	26.04
Online via WebCT	25	4.71	24.76
Class-in-a-Box	21	3.60	23.95

Table 11.
Summary of Analysis of Variance (ANOVA) Between Groups for the Instructor

Source	DF	SS	MS	F	p
Between Groups	2	49.299	24.650	1.142	.325
Error	66	1424.469	21.583		
Total	68	1473.768			

Note. *p<.05 level

Discussion

Previous research studies have compared the academic performance of distance learners via the online learning environment to that of the traditional learner. Consensus from the studies indicates that there is no significant difference in the achievement of students participating in these environments (Paulsen, 1997; Baker et al., 1997; Diaz, 2000; Schutte, 1998). However, few studies have compared traditional learning with the newer multimedia online technologies (e.g., digital video, multimedia CD-ROM learning) that are emerging in educational entities in distance education today (Navarro & Schumaker, 2000; Liaupsin, 2002; Barron & Baumbach, 1990). The current study utilized the newer technologies (e.g., multimedia CD-ROMs, digital video) that are available as a means of delivering instructional content to students.

The purpose of this study was to investigate whether there were any differences in the achievement, student satisfaction, and instructor course evaluations of pre-service general education students who received instruction in three different types of learning environments (a traditional classroom, an online classroom via WebCT, a class-in-a-box via multimedia CD-ROMs). The various methods used to deliver the instructional content included lecture/transcribed lecture notes, PowerPoint notes, digital videos, and the textbook and were identical across the three environments. Findings from the current study support the previous findings that there was no significant difference found between the achievement and satisfaction of students who were instructed in the traditional, online, or class-in-a-box environment. All three environments were equally effective in delivering the instructional content of the course. In addition, all of the students were equally satisfied with the type of instructional media in which they participated.

The study had a limitation in that it only assessed a limited sample size (76 students) across the three instructional environments. In addition, in the current study students in the distance education sections were required to attend class on campus at the beginning and end of the semester. In a true distance education class, students are not required to attend class to take tests. Nonetheless, the data supports educating students via distance education with newer multimedia technologies.

Recommendations for Further Research

Research concerning distance education has focused on areas taught via instructional television and online formats (e.g., WebCT). However, research concerning the use of newer multimedia technologies (multimedia CD-ROM learning, digital video) is in its infancy and there is need to continue studies in this area. Based on the results of this study the following areas are suggested for further research.

1. Follow-up research using multimedia CD-ROMs as a media of instruction in structured and unstructured environments is needed. This research is needed to ascertain the instructional methods that should be embedded into CD-ROM instruction to ensure student success. Additional research into the effectiveness of this form of instruction would be valuable.

2. Future research is needed to identify the learning characteristics and attitudes of students participating in multimedia CD-ROM stand-alone classes. This research can provide information concerning the characteristics of students who would be successful in CD-ROM stand-alone classes.

3. Research is needed concerning the variety of methods used to communicate in distance education courses. This research is imperative to develop strategies to increase the interaction among students so that they experience less isolation in multimedia CD-ROM courses.

4. More research is needed concerning the instructional methods (e.g., digital videos, PowerPoint notes) that are effective in different types of distance education courses. It may be that certain methods work best with certain types of instructional media.

5. More research is needed that compares the efficacy of learning through traditional instruction compared to online learning and instruction via multimedia CD-ROM stand-alone courses. Because the use of CD-ROM stand-alone courses is just beginning, additional research is needed to better understand this learning environment as compared to more traditional instruction.

6. Research is needed that examines the use of multimedia CD-ROM stand-alone courses with a variety of academic levels of students. This would provide information to identify whether or not CD-ROM courses are best suited in lower level coursework (e.g., with sophomore students) or in more advanced coursework (e.g., with graduate level students).

7. Finally, qualitative research is needed to better understand the use of multimedia CD-ROMs in pre-service teacher education. In the current study, students in the CD-ROM course were not interviewed, nor were their experiences chronicled over time.

Conclusion

Typically, multimedia CD-ROM instruction is a stand-alone course in which instruction is contained on a CD-ROM and students progress through the course/content at their own pace (Inglis, Ling, & Joosten, 1999). The benefits for adding the type of instructional media, multimedia CD-ROMs are many. This media of instruction offers the potential to serve large numbers of students who live in remote areas with limited online access. For example, students need only to have access to a computer equipped with a CD-ROM drive to access the course. They do not have to worry about the online environment to access instructional content.

In contrast, students in an online environment can find it frustrating if they are using a phone modem rather than a broadband connection (e.g., cable, DSL) to access the online environment. In addition, the age of the computer or technology can impact the amount of time it takes to download information or view digital video. It also can be frustrating for students if they lose their connection frequently. Thus, the use of multimedia CD-ROM stand-alone courses for learners in remote areas and those with slower online access may increase instructional options for instructors.

It is also important to note that the digital videos used in the study were an effective method used in all three types of instructional media. Digital videos utilize newer multimedia technologies that were previously unavailable prior to the mid 1990s. Digital videos can be used to enhance any course (traditional, online, multimedia CD-ROMs) by bringing the experts or the instructor to the instructional setting. Students in previous studies in which digital videos were used noted that the video and audio clips when used in the course made the course more realistic (like a traditional setting) (Bliss & Mazur, 1996).

In summary, the results reported in this study provide support for using newer multimedia technologies in instructing students in distance education courses. All three types of instructional media (i.e., traditional, online via WebCT, class-in-a-box via multimedia CD-ROMs) were equally effective in presenting the instructional content. Student achievement gains from the pretest to the posttest did not yield any significant results to suggest that one type of instructional media was more effective in delivering the content. In addition, students in all three groups were equally satisfied with the type of instructional media in which they participated. Finally, students in the three instructional groups perceived that the instructor presented the content of the course effectively. Results from this study provide support for using the online environment and multimedia CD-ROM instruction to deliver instructional content.

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Ashley A. Skylar is Assistant Professor in the Department of Special Education, California State University, Northridge. Kyle Higgins is Professor in the Department of Special Education, University of Nevada Las Vegas. Randall Boone is Professor in the Department of Curriculum and Instruction, University of Nevada Las Vegas. Paul Jones is Professor in the Department of Educational Psychology, University of Nevada Las Vegas. Tom Pierce is Professor in the Department of Special Education, University of Nevada Las Vegas. Jeff Gelfer is Professor in the Department of Special Education, University of Nevada Las Vegas.

Correspondence concerning this article should be addressed to Ashley A. Skylar, California State University, Northridge, 18111 Nordhoff Street, Northridge, CA 91330-8265. Email to: ashley.skylar@csun.edu.

Handwritten and Word-Processed Story Retellings by School-Aged Students Who Are Deaf

MELODY L. STONER
SUSAN R. EASTERBROOKS
Georgia State University
JOAN M. LAUGHTON
University of Georgia

Research on children with normal hearing shows that the word-processed narratives they produce are better than their hand-written narratives. Hearing children come to school with prior experience in narrating stories, and in school they learn to transfer this to written narrative form. However, children who are deaf and hard of hearing have less experience with storytelling than their same-age hearing peers, and putting stories into written form is a challenge. The purpose of this study was to compare the handwritten narratives of students who are deaf or hard of hearing with their word-processed narratives to see if the benefits experienced by hearing students hold true for students who are deaf. Twenty middle-school age students were asked to provide a narrative using cartoons as stimuli for obtaining written and word-processed samples. Results were compared for length of t-unit, narrative level, and story grammar. For the subjects in this study, the word-processed samples received higher scores for length of t-unit than did the handwritten products, indicating that word-processing encourages more complete products than handwriting. Implications are discussed.

Active participation in most cultural groups, financial independence, and general success in life are contingent upon literacy (Gillam, Pena, & Miller, 1999). An important literacy skill is the ability to retell a story. Most hearing children can comply when asked to tell a story (Klecan-Aker, McIngvale, & Swank, 1987) and can understand and use all the elements of story grammar by age nine (Yoshinaga-Itano & Downey, 1996). Children who are deaf do not always have the opportunity to listen to and learn narrative structure and have less experience with telling and retelling stories to parents, siblings, and teachers than same-age hearing children do. Therefore, they cannot always comply with a tell- me-a-story request, whether orally, through sign, or in print. This problem continues through the school years, and by middle school written language problems are clearly evident.

Two options students have for providing a written retelling are through handwriting and by the use of a word processor. Most of the research comparing these two options has been done with hearing participants and has shown that word-processed products are better than handwritten products (Bangert-Drowns, 1993; Hawisher, 1989). The purpose of this study was to investigate whether deaf and hard of hearing students produced better products through word processing than through handwriting, as do their hearing peers.

REVIEW OF THE LITERATURE

The difficulties students with educationally significant hearing loss have in acquiring receptive and expressive language skills have been well documented (Lederberg & Everhart, 2000; Moeller, Osberger, & Eccarius, 1986; Osberger, Moeller, Eccarrius, Robbins, & Johnson, 1986; Weiss & Johnson, 1993). Students with learning disabilities (MacArthur & Graham, 1987) and students in remedial programs (Bangert-Drowns, 1993; Hawisher, 1989) benefit from the option to produce narratives through word-processing. Most studies available have looked at t-units, narratives, and story grammar as dependent variables or at the influence of various prompts on performance.

T-units, Narrative Level, and Story Grammar

Story retelling, as opposed to story telling, is a useful way of demonstrating communicative competence (Silliman, 1989). Culatta, Page, and Ellis (1983) demonstrated that story retelling is a way of screening communicative competence, as it requires comprehension and expression of information presented sequentially. Story grammar can be elicited through students' retelling and is especially effective in evaluating the story schema development of young children (Rand, 1984). A story retelling can provide information regarding the student's recollection of major and minor points as well as story organization. Instead of comparing the retelling to the original, the new story may be viewed as its own story, valuable and worthy in itself (Kalmbach, 1986).

One way to examine written story retellings is to measure mean length of t-units (Klecan-Aker & Blondeau, 1990; Yoshinaga-Itano & Snyder, 1985). A t-unit is defined as one main clause and all the subordinate clauses embedded in or attached to it. For example, "John is my friend" has one t-unit while "John is my friend and he is in my Boy Scout troop" has two t-units. The mean length of t-unit (MLTU) is derived from a ratio of total number of t-units to total number of words. A longer MLTU means more mature written language. Yoshinaga-Itano and Snyder (1985) found that ten to fourteen year old hearing students produced a larger MLTU than did their 10 and 14-year-old deaf and hard of hearing counterparts, and students with normal hearing produced a higher mean length of t-unit when spontaneously generating oral narrative language than when prompted with a visual or auditory stimulus (Klecan-Aker et al, 1987).

Another way to examine story retellings is by narrative analysis. Narrative level refers to the level of story organization represented in a written product. For example, "the is boy and go" is defined as a heap and is at the lowest narrative level, whereas true narratives are the highest level. Narrative ability is an important predictor of reading comprehension ability in deaf children (Crosson & Geers, 2001). Available studies reporting results of narrative research with deaf students find it a useful tool in evaluating narrative discourse competence (Griffith & Ripich, 1988; Griffith, Ripich, & Dastoli, 1990; Yoshinaga-Itano, Snyder, & Mayberry, 1996). Klecan-Aker and Blondeau (1990) studied eight students with hearing losses and found that 62.5% of participants wrote true narratives, 25% wrote focused chains, and 12.5% wrote a sequence story. Crosson and Geers (2001) found that spoken narrative ability scores correlated significantly with speech perception, language syntax, and reading test scores in 8 and 9-year-old deaf students who had received cochlear implant. Analysis of narrative level may provide a clearer picture of the temporal (i.e., clauses referring to time and sequence of action) and causal (i.e., clauses that give the reader insight into the narrator's attitude and the character's motives and feeling, or causes) narrative development of children who are deaf.

A third option for studying story retellings is to examine story grammar. Story grammar includes the components of initiating events, attempts, endings, consequences, settings, and internal responses. Several researchers have used story grammar analysis to look at the logical organization of semantic relationships within a story. Klecan-Aker and Blondeau (1990) studied handwritten narratives of eight students with severe to profound hearing loss. All the participants described an initiating event. All but one participant described attempt, consequence, and ending features; all but two described the setting; and all but three reported an internal response in the story. Yoshinaga-Itano and Downey (1992) studied the handwritten stories of 284 students with severe to profound hearing loss. Of these students, only 79 were able to handwrite a complete story containing all story grammar elements. Yoshinaga-Itano and Downey (1996) studied 474 students with mild to profound hearing loss and found that at age eighteen, the subjects with profound hearing loss did not include as many story grammar elements in their writing as did 9-year-old hearing subjects. The above sources consistently reported poor performance on written tasks among their participants with hearing loss.

Type of Stimulus

The type of stimulus used to elicit a narrative may affect a student's recall of the story. Story grammar components used and length of story may vary with stimulus (i.e., wordless picture books or movies) and transmission variance (i.e., oral or written) (Scott, 1988). Klecan-Aker et al. (1987) found that third grade students with normal hearing produced more complex story patterns when given prompts than when not. When students with hearing loss were asked to tell a story from a picture that supported the story, they recalled much more than when recalling from memory alone (Griffith & Ripich, 1988). Other stimuli reported have been pictures (Yoshinaga-Itano & Snyder, 1985; Yoshinaga-Itano et al., 1996), fantasy scenes (Marschark, West, Nall, & Everhart, 1986; Everhart and Marschark, 1988; Marschark, Mouradian, and Halas, 1994), story suggestions (Everhart & Marschark, 1988; Marschark et al., 1986, 1994), free-writes (Klecan-Aker & Blondeau, 1990), movies (Weiss & Johnson, 1993), and silent films (O'Donnell, Griffin, & Norris, 1967). Klecan-Aker and Blondeau (1990) reported the retelling skills of students with hearing losses when given the prompt that stories have a beginning, middle, and an end. One stimulus that did not appear in the literature reviewed was the use of cartoons to elicit written narratives. Television has become a natural, everyday stimulus for communication and story telling. In fact, "…the job of summarizing a movie plot to a friend or acquaintance is a real-life situation, and therefore one could gain some insight through this task into how well the subject would function when his or her narrative abilities are called upon in a social venue" (Weiss & Johnson, 1993, p. 56). Since students who are deaf and hard of hearing tend to have limited verbal skills and in addition are oriented to learning visually, cartoons were chosen as the prompt for this study. Cartoons also possessed the story grammar elements that the task was attempting to elicit. Additionally they provided a level of excitement that was motivating to students.

Summary

In summary, most of the research reviewed has indicated that there are differences between the handwritten and word-processed products of students with normal hearing. However, a review of the literature revealed no studies on word-processed narratives by school age children who are deaf; therefore, it is not known if the method selected for writing has an impact on their story retellings. Due to the constraints on the process of narrative discourse imposed by hearing loss, students who are deaf or hard of hearing are at risk for writing disability and cognitive delay, possibly manifesting in slowed or incomplete acquisition of story grammar and limited narrative level growth.

The research questions guiding this investigation were:

1. Do deaf and hard of hearing students produce a more advanced t-unit under word processing conditions than handwritten conditions?
2. Do deaf and hard of hearing students produce a higher narrative level under word processing conditions than handwritten conditions?
3. Do deaf and hard of hearing students produce more elements of story grammar under word processing conditions that hand written conditions?

The hypotheses examined were that school-age students who are deaf or hard of hearing (a) do not include a greater number of story grammar elements, (b) do not exhibit a higher level of narrative development, and (c) do not present higher scores in mean length of t-unit in their word-processed story retellings than in their handwritten story retellings.

Method

Participants

Twenty students with hearing losses from a state in the Southeast participated in the study. An N of 20 is considered to be sizable in studies pertaining to students with hearing loss (Easterbrooks, 1999). In addition to the population being of low incidence, approximately 80% of students with hearing loss are educated in their local schools. Most local school systems serve 7 or fewer of these students across the age span; therefore, locating a large number of students who are all the same age and use the same communication system limits researchers' abilities to study this population. All participants in this study used total communication (i.e., simultaneous sign and spoken language). Fourteen participants were female and six were male. Three participants were from a residential school for the deaf, 11 from a day school for the deaf, and six from two local school systems: one urban fringe and one rural. The five participants from the local school system on the urban fringe included one student who was fully mainstreamed with a sign language interpreter, two students who were fully self-contained, and two who were partially self-contained and partially mainstreamed with a sign language interpreter. The participant from the rural school system was fully mainstreamed with a sign language interpreter. Participants ranged in age from 10 years – 11 months, to 14 years – 8 months. Etiology of hearing loss was available on eight participants. There were a disproportionate number of females in the study group relative to the general population of students with hearing loss. (see Table 1)

The participants' unaided hearing losses ranged from 97 dB PTA to 120+ dB PTA. The mean unaided loss of the group was 109 dB PTA. Age at time loss was identified was available on thirteen participants and ranged from birth to 4 years – 6 months. Age at first amplification was available on 13 participants and ranged from 8 months to 6 years. Thirteen participants wore at least one hearing aid, two participants wore cochlear implant users, and five participants utilized no form of amplification, indicating that it did not help. They had a mean hearing loss of 119 dB PTA. Two were former cochlear implant recipients currently not utilizing amplification. They had a mean hearing loss of 108 dB. Aided mean loss was not calculated as information on audiograms was reported inconsistently. All but five participants' audiological evaluations had been completed within the last year. All participants either had passed a vision screening within the last year or had vision corrected with glasses or contacts.

Each participant's primary language in the home was reported as English, either signed or simultaneously signed and spoken with the exception of two whose parents were both deaf and were users of American Sign Language (ASL) and one whose foster father was deaf. Two teachers for each participant reported that there were no additionally documented learning problems. One teacher of two participants indicated one had a suspected learning disability and another had a suspected processing disability; however, these suspicions had not been documented via diagnostic testing, so any results disaggregated for these three participants would have been insignificant.

All participants were able to write five sentences with a prompt, as established by one or more writing samples submitted by the participants' teacher before beginning testing. A minimal sentence was described as a noun plus verb. The initial recruitment criterion was a five-sentence story in response to a prompt. A minimum of a five-sentence story with prompt was needed to provide enough information to analyze. Each participant had at least beginning keyboarding ability, as reported by teachers and screened by the researcher. This was defined as the ability to locate and press keys without help from another person. A minimum beginning ability in keyboarding was required in order to avoid findings skewed in favor of handwriting.

Table 1.
Participants' Demographic Data

		%
Gender		
Male	6	30
Female	14	70
Age Range		
Male	10-11 to 14-8	
Female	11-1 to 14-7	
Age Mean	12.6	
Race/Ethnicity		
Black	7	35
White	11	55
Asian	1	5
Hispanic	1	5
Hearing Loss		
Range of Unaided Loss (Not measured past 120)	97-120	
Mean of Unaided Loss	108.9 dB PTA	
Range of Aided Loss	32-100 (14 reporting)	
Number with CI	2	10
Current Educational Placement		
Fully Mainstreamed with Interpreter	2	10
Partially Mainstreamed with Interpreter	2	10
Self-Contained in LSS	2	10
Residential School for the Deaf	3	15
Day School for the Deaf	11	55
Etiology		
Meningitis	5	25
Cytomegalovirus	1	5
Allergic Reaction	1	5
Hereditary	1	5
Not Available or Unknown	12	60
Age at time of ID		
Range	0 to 4-6 (13 reporting)	
Age at time of first amplification		
Range	0-8 to 6-0	
Mean	2-4	

Setting

Experimental testing procedures were conducted in a variety of locations including a school psychologist's office, a professional library, a corner of a classroom, and an interpreter's office. Each setting was quiet, free of distractions, amply lit, and had either desks or tables for the researcher and participant, as well as outlets for the video cassette player, television/monitor, and laptop.

Procedures

Central office staff in the participating schools sent permission forms to parents of all eligible students. Only students whose parents agreed for them to participate were included. Participants watched videotapes then wrote or typed their best story that would describe events in the videotape so that their teacher, who was unable to watch it, would understand what happened. This direction was given so that the participants had an audience in mind. All students were asked to participate and help the researcher. Only one student did not wish to participate, but when the teacher explained that his parents had given permission, he complied. The following procedures for data collection were followed:

Day 1

Typing test and writing test. A speed test in providing home address (Dunn & Reay, 1989) via handwriting and word processing and an assessment of typing speed were conducted using an IBM ThinkPad, MSWord, and a typing software entitled Animated Beginning Typing (Guthery, 1996) (see Table 2). The researcher asked the participant either to write and then type or to type and then write his name and address (Dunn & Reay, 1989). Each participant was shown how to use the mouse and backspace button on the laptop before typing her/his address. The researcher calculated the handwriting to typing ratio, or number of characters per minute. All writing was completed with notebook paper and two pens or pencils (Lamme, 1979) provided by the researcher. All word processing was completed with a laptop provided by the researcher. The word-processed addresses were saved to disk. Next, the Animated Beginning Typing test was administered. The participant was asked to look at the screen and copy the letters on the screen as accurately and quickly as possible with as few errors as possible. There were three trials, one with twenty letters, a second with forty, and a third with sixty. Time taken to copy, number of errors, and words per minute were calculated. The researcher averaged the three trials' words per minute together to calculate mean number of words per minute (see Table 2).

Table 2.
Participants' Handwriting and Word-Processing Speed

	Range	Standard Deviation	Mean	Median
Words per minute on word processor	4.03 to 17.17	3.92	9.9905	9.32
Characters per minutes				
Handwritten	.32 to 3.43	1.693		
Word processed	.42 to 2.53	1.171		

Watch and retell two videos. Participants watched a *Pink Panther* (Mirisch Films, Inc., 1968) cartoon and a *Tom and Jerry* cartoon (Metro-Goldwyn-Mayer, 1945, 1946). These cartoons were chosen because of their appeal to older students. Cartoons for younger children portray situational visual humor that changes from moment to moment. The cartoons chosen had a clear beginning, middle, and end, and the plot line carried throughout the entire cartoon. Next, the researcher read and signed a script of the procedures for students to follow. The students were then given a copy of the procedural script. They watched the first video a second time. After watching the videotape twice the students were told to write or type the best story they could about what happened in the videotape for their teacher who was unable to watch it. The purpose for that directive was "to facilitate a sense of audience or to maintain communicative intent in the writing." (Laughton & Morris, 1989, p. 90). The students wrote their version or produced it on a word processor. After the first video, participants took a 5-minute break for restroom use and water. Upon return they viewed the second videotape twice and retold the second cartoon's story via the opposite writing method used in the first retelling. The participants were informed that spelling was not an issue (Laughton & Morris, 1989; Golden & Vukelich, 1989). The students were given 20 minutes to write, with a time reminder at the end of 15 minutes. The handwritten stories were later typed and printed. The reason for typing the handwritten stories was so that the researcher's assistant would be unaware of which stories were handwritten and which stories were word-processed. After typing 20 stories the researcher might be expected to forget which stories were typed and which were handwritten, although some retention of information was likely introduced. However, this was the most efficient way to control for this kind of bias given time and budget constraints. In order to assure counterbalancing of method, story, and order of stories, subjects were carefully assigned to a specific sequence of production and cartoon viewing. This was accomplished by making a chart of participants, assigning them numbers, and assigning the four cartoons letters. Participant One watched the first cartoon first, the second cartoon second, the third cartoon third, and the fourth cartoon fourth. Participant Two watched the second cartoon first, the third cartoon second, the fourth cartoon third, and the first cartoon fourth. This procedure was followed until all the participants were assigned an order in which to watch the cartoons.

Day 2

On the second day the students repeated the procedures above, watching a second *Pink Panther* cartoon and a second *Tom and Jerry* cartoon twice and producing retellings, once via handwriting and once via a word processor. The four videos ranged in length from 6 minutes – 34 seconds to 7 minutes – 20 seconds. Each story was read to the student and questions were asked about it if there were any unclear points (MacArthur & Graham, 1987).

Data Analysis

The data were analyzed using Statistical Programs for Social Sciences (SPSS) Version 10.0 for Windows. For each dependent variable, related samples t-tests were run. Significance level was set at .05 family-wise, or .01 for each test. The primary independent variable for data analysis was method of production: handwriting or word-processing. The dependent variables for this study were total number of t-units, total number of words, mean length of t-unit, total number of story grammar elements included, and level of narrative demonstrated within both methods of writing (See Table 3).

The first part of the scoring protocol for story retellings consisted of a quantitative analysis via enumerating t-units, total number of words, and mean length of t-units. The second part of the scoring protocol for story retellings consisted of enumerating story grammar elements present (Klecan-Aker & Blondeau, 1990; Laughton & Morris, 1989; Yoshinaga-Itano & Downey, 1992; Yoshinaga-Itano et al., 1996). Each story could receive a potential raw score falling between zero (the story did not include any story grammar elements) and 7 (the story included at least one example each of main character, initiating event, attempt, internal response, internal plan, consequence/outcome, and reaction/ending). If the story included more than one example of a story grammar element, it was not calculated into the final raw score.

The third part of the scoring protocol for story retellings consisted of a qualitative narrative level assignment (Applebee, 1978; Klecan-Aker et al., 1987; Klecan-Aker & Blondeau, 1990). Each story could receive a potential raw

Table 3.
Samples of student performance at different rating levels

	T-unit	Narrative Level	Story Grammar
Example of sentence(s) in a sample given lowest rating.	The are you golf.	I see tree hard on bee.	Pink cat are so tired.because she have a long tiar. And later worn is so sad, because pink worn do not like him, but that was not pink worn.
Example of sentence(s) in a sample given highest rating.	…then Jerry closed and heard the gulping sound and he opened again and looked at Tom again and took the bowl with him again.	The mother bird pick up the Pink's tail to feed the mother bird's baby!!! Pink started mad and get his tail back!!! The mother bird and bird babies pick on his tail!!! Pink have to keep patient!!!	Then police chase the Pink. Pink don't know what go on so he ran away from the police and then hide in the trash. Finally the rich man found his pocket clock back.

Table 4.
T-unit, Word, Narrative Level, and Story Grammar of Word-Processed Versus Handwritten Retellings

	Handwritten		Word-Processed		Obtained t	df	Significance Level
	M	SD	M	SD			
Total Number of T-Units	27.98	11.02	29.55	17.05	-.66	19	.26
Total Number of Words	186.90	76.55	216.45	137.23	1.61	19	.06
Mean Length of T-Unit	6.72	1.30	7.34	1.34	3.76	19	*.0005
Narrative Level	3.10	.77	3.02	.72	.62	19	.27
Story Grammar Score	4.10	1.67	4.48	1.50	-1.49	19	.08

p. < .05

score falling between 1 (a heap) and 6 (a true narrative). If the story included more than one narrative level, the highest level it fit into best was assigned (see Appendix A for scoring protocol and descriptions of all features evaluated).

Reliability

Inter-rater reliability measures compared the researcher's scores with those of the researcher's assistant. The assistant was trained in the scoring procedure for 100% reliability. Both the primary researcher and the assistant scored each story individually then reconvened to discuss scores and resolve discrepancies, using a point-by-point strategy. All discrepancies were resolved to 100% agreement. Percentages of agreement were at the 100% agreement level for total number of t-units, total number of words, mean length of t-unit, narrative level, and story grammar. In counting total number of words, story titles and endings (i.e., "the end") were not included, as they could not be considered a complete t-unit for analysis. Contractions were counted as one word.

Intra-rater reliability was also calculated. In order to assess intra-rater reliability, eight stories (10% of the total 80) were randomly selected by someone not initially involved in analysis and scored again by the primary investigator without reference to the original scoring. Percentages of intra-rater agreement were 100% for all categories. Intra-rater reliability for typed stories (originally handwritten) was 97.4% for words included (of 1,289 words re-typed, 33 had been left out in the initial typed versions.); 99.7% for words misspelled (of 1,289 words re-typed, 3 had been spelled correctly in the initial typed versions, which should have been misspelled in the initial typed version.); and 99.8% for capitalization (of 1,289 words re-typed, 2 had been capitalized incorrectly in the initial typed versions. One was initially capitalized that should not have been capitalized, and one was only capitalized in the first letter, while it should have been capitalized in each letter of the word.) These percentages were established by counting total number of words in the eight stories combined (1,289), then counting the total number of words in the re-typed versions with errors.

Each error in the re-typed version was actually an error in the initial typed version, as the re-typed versions did not include any errors when compared with the original handwritten products.

Results

The total number of t-units and total number of words produced were similar in handwritten and word-processed conditions (see Table 4). Mean length of t-unit, however, was significantly longer in the word-processed condition (t = -3.761, p=.0005). Additionally, mean length of t-unit was affected by educational placement in that two subjects in a residential setting presented with a dip in mean length of t-unit at age 13.03, unaffected by stimulus or writing method.

No significant difference was found for narrative level (see Table 4). On average, stories in both conditions were assigned a narrative level of three. Most of the stories were primitive narratives, containing initiating event, attempt, and consequence. The total number of story grammar elements did not differ for handwritten products compared with word-processed products. As shown in Table 4, the mean number of elements per story was approximately 4 – 4.5 in both conditions. T-tests were not completed for the many individual elements because they were so descriptively similar across conditions. An ANOVA was calculated to determine if gender differences existed in performance on t-units, narrative levels, or story grammar, the results of which were showed an insignificant relationship. Regardless of handwriting or word-processing, students did tend to include main character, initiating event, attempt, and consequence, sometimes included internal response and resolution, and rarely included internal plan.

Examination of stimulus effect revealed that the *Pink Panther* cartoons resulted in more t-units than the *Tom and Jerry* cartoons. See Table 5 for means, standard deviations, critical values, degrees of freedom, and significance levels for this analysis. The *Tom and Jerry* cartoons contained more distinct actions, while the *Pink Panther* cartoons demonstrated more implied problem solving. Implied meaning and problem solving may have led the students to use more developed clausal structures as opposed to the less complex language required to convey distinct actions, thus influencing the students' production of higher order grammar. See Table 6 for means and standard deviations of presence of individual story grammar elements within each cartoon, including group (handwritten and word-processed) means (M) and standard deviations (SD).

Table 5.
Group Means, Standard Deviations, T-tests' Obtained Values, Degrees of Freedom (df), and Significance Levels for Cartoon Stimulus

	Pink Panther		*Tom and Jerry*		Obtained t	df	Significance Level
	M	SD	M	SD			
Total Number of T-Units	30.45	14.39	27.05	12.78	2.89	19	*.005
Total Number of Words	211.28	105.59	216.45	137.23	2.25	19	*.019
Mean Length of T-Unit	6.96	1.08	7.34	1.34	-2.158	19	*.022
Narrative Level	3.025	.73	3.02	.72	-.36	19	.36
Story Grammar Score	4.23	1.57	4.38	1.60	-.65	19	.26

$p < .05$

In summary, a comparison of writing methods resulted in one significant difference of a potential five: mean length of t-unit. Thus, sufficient evidence is present to reject the null hypothesis that there are no differences between handwritten and word-processed products by students who are deaf in the area of mean length of t-unit. In this case, the higher mean was present in word-processed products. Total number of words, total number of t-units, narrative level, and total number of story grammar elements included were not affected by type of writing method. Thus, insufficient evidence is present to reject the null hypothesis that there are no differences between handwritten and word-processed products in the areas of total number of words, total number of t-units, narrative level, and total number of story grammar elements included.

Discussion

This study asked the question: Do differences exist between handwritten and word-processed story retellings by school age students who are deaf in the areas of total number of words, total number of t-units, mean length of t-unit, narrative level, and total number of story grammar elements included? The research reported in the literature completed with hearing school-age students comparing handwritten and word-processed products varied. This study found that the technology of word-processing affected the story retelling ability of students with hearing loss in mean length of t-unit.

Table 6.
Mean and (SD) Story Grammar Elements Included For Each Cartoon

	Pink Panther cartoons		*Tom and Jerry cartoons*	
	1	*2*	*1*	*2*
Main Character	.90	.95	.95	.90
	(.31)	(.22)	(.22)	(.31)
Initiating Event	.85	.95	.90	.80
	(.37)	(.22)	(.31)	(.41)
Internal Response	.35	5.000E-02	.75	.55
	(.49)	(.22)	(.44)	(.51)
Internal Plan	.10	.15	.10	.10
	(.31)	(.37)	(.31)	(.31)
Attempt	.75	.90	.85	.75
	(.44)	(.31)	(.37)	(.44)
Consequence	.70	.85	.80	.70
	(.47)	(.37)	(.41)	(.47)
Resolution	.50	.45	.40	.25
	(.51)	(.51)	(.50)	(.44)

Mean Length of T-Unit

In the present study, mean length of t-unit was found to be significantly higher in word-processed products than in handwritten products. These results do not support previous research on hearing students (MacArthur & Graham, 1987). Trends tended to follow those reported by Yoshinaga-Itano and Snyder (1985) in that mean length of t-unit tended to increase with age regardless of stimulus or writing method.

Narrative Level

There was no significant difference in narrative levels between handwritten products and word-processed products. A narrative level of 3 is representative of primitive narrative, which indicates that the participant produced an initiating event, attempt, and consequence centralized around a central theme. Klecan-Aker and Blondeau's (1990) subjects yielded higher narrative levels. In general, students with hearing loss do not produce narratives that are as advanced as those of their hearing peers. This supports our previous contention that lack of experience may contribute to poorer narrative performance.

Story Grammar

The results of this study differed from Yoshinaga-Itano et al. (1996) and Klecan-Aker and Blondeau (1990) as main character was produced more often than initiating event, while in their studies, initiating event was the most often produced story grammar element, and then setting (main character). The results of this study followed trends as established by Klecan-Aker and Blondeau (1990) and Yoshinaga-Itano and Downey (1996) in that initiating event was one of the most common occurrences and internal response/response the least common. Klecan-Aker and Blondeau (1990) and Yoshinaga-Itano and Downey (1996) did not score for internal plan. The remaining story grammar elements did not follow trends established by these researchers.

Limitations of this Study

A chronic problem in research in deaf education is that the population is of low incidence, making it difficult to locate a large number of students who are all the same age and use the same communication system. Further, students who are deaf represent a heterogeneous group so making generalizations from one sub-population to the next is difficult to do. This represents the biggest challenge to the veracity of any study of students with hearing loss, resulting in several limitations to the study. First, the varied educational placement of participants in this study may affect the range of generalization. Students in this study came from five different educational settings, unlike the students in other studies (Klecan-Aker & Blondeau, 1990; Yoshinaga-Itano & Snyder, 1985). Further studies might seek to determine if differences in performance based on placement generalize to larger populations. Second, this study did not seek to control for the language background that each student brings to the instructional process. The present study controlled for students in total communication settings, limiting generalizations to that group. Third, the process of learning to write unfolds over a period of many years. It would be of benefit to know at what age students with hearing loss would benefit most from work on writing skills via handwriting versus writing skills via word processing. A fourth limitation of the study pertains to the nature of the stimuli, which were long and potentially tiring for the participants. Instructions were also long and repetitive, being read to each participant prior to each viewing of cartoon stimulus for the first time. Several participants indicated they understood the instructions the first time presented, and some did not read the hard copy provided to them after the initial review.

In this study, 18 of 20 participants were faster with handwriting, which would appear to greatly skew the results in favor of handwriting; however, this was not the case. This begs the question of whether the results would differ had participants had equal competency in both methods of writing. In actuality, in spite of the low levels of word processing speed, results found via mean length of t-unit were significant. Had the participants' handwritten and word-processed competencies been more equal, perhaps the results would have been more significant. Due to the heterogeneous nature of the population, varied educational placements, long, repetitive stimuli and instructions, and unequal rates of handwritten and word-processed production, caution is urged in interpretation.

Since national literacy outcomes for students with hearing loss are so poor, this topic warrants further investigation, most importantly including a control group. Additional research on all aspects of writing is sorely needed. First, stimuli should be chosen carefully, with consideration given to what one wishes to analyze. Stimuli should be presented only once because some participants grew weary of watching a cartoon twice, especially if they understood the contents the first time. Further research into the kinds of stimuli that are most likely to yield higher narrative levels or story grammar levels or more sophisticated t-unit analyses would assist teachers in making research-based decisions regarding their choice of instructional tools and materials, since different types of stimuli yield different results. This would determine which stimuli would present with the highest means and best products in areas of interest. Secondly, shorter instructions should be utilized. Participants grew weary of hearing the instructions four times. In addition, deaf students both with basic and remedial writing skills should be recruited. The participants recruited for the present study had normal writing skills, and were not considered basic or remedial by their schools. Next, a higher number of participants should be recruited for the results to be more generalizable necessitating a multi-state effort. Controls for educational placement and intelligence should be strictly kept.

One area requiring particular attention in further studies would be the comparison of participants with equal speed, or, small variance in speed, in handwriting and word-processing. In this way, transcription rate would not be a factor, and the story retellings would be more representative of true mean length of t-unit, narrative level, and story grammar via method of writing rather than being skewed due to unequal rates of transcription.

Conclusion

Children with normal hearing bring to school the ability to tell stories, which is also referred to as the production of narratives. This affords them the ability to transfer that skill to written form. Children with hearing loss do not necessarily have the ability to tell stories, so writing stories is a challenge. This study compared handwritten and word-processed narratives in 20 middle-school age students who were deaf, using children's high-action low-language cartoons as stimuli for analyzing written stories. For the subjects in this study, word processing led to increased mean length of t-unit, as compared with handwritten products, indicating that word-processed products are more advanced than handwritten products. This information adds to the knowledge base regarding the narrative skills of students with hearing loss.

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Melody Stoner is a doctoral student in the Department of Educational Psychology and Special Education at Georgia State University. Susan Easterbrooks is Professor in the Department of Educational Psychology and Special Education at Georgia State University. Joan Laughton is Professor in the Department of Communication Sciences and Disorders at the University of Georgia. Address correspondence to Susan Easterbrooks, Georgia State University, P. O. Box 3979, Atlanta, GA 30302-3979. Email to: seasterbrooks@gsu.edu.

Considering Response Efficiency as a Strategy to Prevent Assistive Technology Abandonment

SUSAN S. JOHNSTON
JOANNA EVANS
University of Utah

Often, specialists in the field of Assistive Technology (AT) are presented with the challenge of teaching learners to utilize AT in order to increase, maintain, or improve their capabilities. Despite best efforts, rates of AT abandonment are alarmingly high. Understanding the factors that may influence an individual's choice to utilize AT may assist interventionists in designing and implementing effective interventions that prevent technology abandonment. This paper discusses some variables that may influence an individual's choice to utilize AT. Furthermore, the potential applicability of manipulating these variables to decrease the probability of AT abandonment are discussed.

Assistive Technology (AT) has enormous potential to enhance the lives of individuals. For example, environmental control units can allow users with severe physical impairments to operate televisions, lights, and other electronic objects; talking watches can increase the independence of users with visual impairments; and vibrating alarm clocks may allow users with hearing impairments to be awakened independently in the mornings. Unfortunately, this potential is often not realized. Individuals with disabilities are frequently dissatisfied with their assistive technology and, as a result, discontinue its use (Philips & Zhao, 1993). Studies suggest that assistive technology abandonment rates range from 8% to 75% (Tewey, Barnicle, & Perr, 1994). One of the reasons given for discontinuance of AT is that the AT did not meet an important functional need (Beigel, 2000; Reimer-Reiss & Wacker, 2000). As a result, the individuals chose not use the AT.

Understanding the factors that influence an individual's choice regarding the use of AT may assist interventionists in designing and implementing effective interventions. When working with individuals who utilize AT, interventionists may be able to manipulate a number of parameters of reinforcement in order to influence a learner's choice between available responses (Johnston, Reichle, Evans, 2004). Some of the parameters of reinforcement that can be adjusted in order to influence a learner's choice behavior are identified in the concept of matching theory (Mace & Roberts, 1993). Matching theory is the basis for the hypothesis that when an individual has the opportunity to choose between two or more possible responses, the response that the learner perceives as most efficient will be chosen. This paper will discuss variables that may influence an individual's choice regarding their use of AT.

Matching Theory to Prevent AT Abandonment

Herrnstein (1961) conducted a study in which he demonstrated that the distribution of behavior among concurrently available functionally equivalent alternatives was dependent upon the history of reinforcement for each of the available behaviors. This led to the hypothesis that when individuals have the opportunity to choose between two or more responses, they will select the response that is perceived as most efficient (Mace & Roberts, 1993). An individual's concept of efficiency is effected by at least four components: (a) rate of reinforcement (Martens and Houk, 1989; Martens, Lochner, & Kelly; 1992; Mace, Neef, Shade & Mauro; 1994; Neef, Mace, & Shade, 1993; Conger & Killeen, 1974; Horner & Day, 1991), (b) quality of reinforcement (Hollard & Davison, 1971; Miller, 1976; Mace, Neef, Shade, & Mauro; 1996; Neef & Lutz, 2001; Neef et al., 1993), (c) response effort (Bauman, Shull, & Brownstein, 1975; Beautrais & Davison, 1977; Horner & Day, 1991; Mace et al., 1996; Skinner, Belfoire, Mace, Williams-Wilson, & Johns, 1997), and (d) immediacy of reinforcement (Logue, 1988; and Rachlin, 1989; Neef et al, 1993; Horner & Day; 1991).

It seems plausible that one or more of the components of response efficiency may influence a learner's use of AT. Consider a four-year-old child with cerebral palsy who chooses to sit and observe activities from afar rather than use his walker to move from one place to another in his preschool classroom. This lack of use may be a result of the physical effort required to use the walker (e.g, if the motor demands associated with operating the walker are too great, the child may choose not to use it). Alternatively, the child may refrain from using the walker because the quality of reinforcement is not substantial enough to warrant its use (e.g., people in the environment do not realize that the child is moving in their direction and therefore do not remain in one place long enough to make the use of the walker worthwhile).

As a second example, consider a learner with motor difficulties who chooses to refrain from eating independently using an adapted plate and utensils. This learner's lack of independence may be a result of the physical effort required to use the AT (e.g., if the motor demands associated with using the utensils are too great, the learner may choose not to use them). Alternatively, the learner may refrain from using the AT because the quality of reinforcement provided is not substantial enough to warrant its use (e.g., the learner may typically receive food regardless of whether or not she feeds herself independently). Finally, the learner may choose not to spontaneously use the AT because too much time lapses between the use of the AT and the delivery of the reinforcement (e.g., it takes too long to grasp and use the utensil to bring food to her mouth to make the use of the AT worthwhile).

A third example of a situation in which response efficiency may effect a learner's choice to use AT relates to the use of one mode of communication over another available mode. For example, consider a learner who is able to reject nonpreferred items via a gesture (e.g., shaking head from side to side) or a voice output communication device (e.g., accessing a symbol in order to emit the phrase "no thanks"). Using a gesture, this learner is able to reject without searching for and accessing the appropriate symbol. Thus, the learner could perceive this as a saving of response effort. However, the tradeoff to this choice is that a listener will only understand the gesture if he/she is looking at the learner. If the listener does not see the learner's gesture, there may be a decrease in the immediacy of the reinforcement. Subsequently, this may effect the learners' choice of mode of communication.

The following sections will further illustrate the potential role of the four components of response efficiency (i.e., rate of reinforcement, quality of reinforcement, response effort, and immediacy of reinforcement) in a learner's choice to use AT. For each component of response efficiency, the results of empirical investigations will be summarized in order to illustrate the potential influence of rate of reinforcement, quality of reinforcement, response effort, and immediacy of reinforcement. In most cases, the authors of these investigations did not design their studies in order to demonstrate directly the operation of the component being discussed. As a result, these summaries provide inferred, rather than direct, evidence of the components of response efficiency.

Role of Response Efficiency on Learner's Choice to Use AT

Response effort. The physical effort required to produce a behavior can significantly effect whether or not a learner will choose to emit that response (Bauman, Shull, & Brownstein, 1975; Beautrais & Davison, 1977). The potential effect of response effort can be applied to a variety of situations. Horner, Sprague, O'Brien, & Heathfield (1990) conducted a study in which the physical effort required for a 14-year-old learner with moderate mental retardation to use a voice output communication aid to request assistance as a communicative alternative to challenging behavior was altered. In the first situation, the learner was required to type the phrase "Help Please" on a voice output communication aid (defined as a high effort / low efficiency response). In an alternative situation, the learner was required to press a single key on the communication aid in order to emit the phrase, "Help please" (defined as a low-effort/high efficiency response). This investigation revealed that the high effort response did not result in a sustained decrease in challenging behavior. However, the low effort response did result in a significant and sustained decrease in challenging behavior. In summary, results of this investigation revealed when the response effort was too great, the learner chose to emit an alternative response (challenging behavior).

Typically, issues related to response effort are associated with the physical effort required to emit a response. However, it may also be important to consider the cognitive effort involved in emitting a response. For example, to prevent hip dislocation following a total hip replacement, many patients are required to use adaptive equipment, such as a sock aid and long-handled shoehorn when dressing. However, some patients find it difficult to learn how to use the equipment properly and efficiently. When the patient has the choice of using the sock aid and long-handled shoehorns, or bending down to place the shoes and socks over his/her feet, the physical and cognitive effort required for the patient to set-up and manipulate the equipment may be greater than the physical and cognitive effort required for the patient to reach for his/her feet. As a result, use of the adaptive dressing equipment may be less likely to be the chosen behavior.

A pilot study conducted by Gitlin, Levine and Geiger (1993) examined the reasons for nonuse of adaptive devices that assists users with activities of daily living, such as eating, dressing and bathing. Two of the common reasons for nonuse were that the users were able to rely on others to complete the tasks and a belief that the equipment was too cumbersome. This suggests that the effort required to use adaptive devices contributes to the user's choice behavior. Specifically, if using assistive devices requires greater physical or cognitive effort than relying on others to complete the tasks, the likelihood that the user will choose to use the AT is diminished.

Rate of reinforcement. Herrnstein (1961) discussed that when an organism is presented with two or more choices; his choice will be directly dependent on the rate of reinforcement delivered for each alternative. For example, if a learner is reinforced twice as often for raising his hand as he is for speaking out of turn, matching theory would predict that this learner will choose to raise his hand more often than he will choose to speak out. This component of matching theory has particular significance for the implementation of AT interventions. Consider a learner who is being taught to use an adapted plate, fork, and cup to increase his ability to feed himself rather than be fed by an assistant. If all other variables are held constant, matching theory would suggest that he must be reinforced (e.g., have the food or drink successfully reach his mouth) more often for feeding himself than when being fed by someone else. If this learner receives the same rate of reinforcement regardless of whether he feeds himself or is fed by someone, there may be little incentive to use the adapted feeding equipment because the rate of reinforcement is not significantly greater than relying on an assistant.

An investigation by Cook and Cavalier (1999) demonstrated how the rate of reinforcement may influence a learner's choice behavior. This investigation was conducted in an effort to increase the exploratory behaviors of a young child with a significant physical impairment. The child had difficulty using her hands and arms. As a result, she rarely chose to manipulate objects in her environment. Based on this, she was taught to use a single-switch to activate a robotic arm that allowed her to explore objects (i.e., dump items from a container) or to bring objects closer to her. During intervention and maintenance, the child indicated interest, via vocalizations and pointing, in manipulating the robotic arm. Furthermore, she was reported to request additional opportunities to use the robotic arm. In terms of matching theory, these outcomes could be explained by concluding that a higher rate of reinforcement was provided by the use of the switch and robotic arm than by her attempts to physically reach for and manipulate objects.

Quality of reinforcement. Mace and Roberts (1993) discussed that when one event is preferred over another, the preferred event has a higher quality of reinforcement. Furthermore, they discuss that quality of reinforcement can effect a learner's choice behavior. When this phenomena is applied to interventions utilizing AT, it would imply that the reinforcement delivered contingent on a learner's use of AT must be preferred over the reinforcement delivered for not using it. For example, consider a learner who is being taught to use an adapted mouse to access computer games. If the learner does not enjoy the computer games, it is unlikely that the quality of reinforcer received for using the adapted mouse will provide adequate incentive for the AT to be used. The learner may instead make the choice to refrain from engaging in the activity.

The influence of quality of reinforcement can be inferred from an investigation by Zhang (2000). In this investigation, the experimenter observed the impact of a computer writing tool (ROBO-Writer) on the written output of 5 fifth-grade students with learning disabilities with written language deficits. The ROBO-Writer software provided assistance with content, word choice, sentence fluency, and convention. The results of this investigation revealed a pattern of improvement (in terms of quality and quantity) on the participants' written products. Furthermore, the experimenter noted that the professional-looking output of the written products motivated the students to share their finished products with peers, teachers, and family members. If the results of this investigation are applied to matching theory, it would seem to indicate that the quality of reinforcement (e.g., ease with which written products were produced, the professional-looking product) influenced the participants' choice to engage in writing activities.

Immediacy of reinforcement. The latency between the use of AT and the delivery of a reinforcer may also influence a learner's choice to use the AT. The influence of immediacy of reinforcement can be inferred from a qualitative study examining the use of assistive devices in school settings (Todis, 1996). In this study, Todis reported on an interview conducted with a teacher in a preschool setting for young children with and without disabilities. This teacher commented that the students with disabilities who used augmentative and alternative communication (AAC) in her class were more likely to opt out of a communicative opportunity rather than choose to tolerate the delay in reinforcement incurred as a result of having to go to another part of the classroom to retrieve their AAC device. If this information is applied to matching theory, it would suggest that the immediacy of reinforcement influences the students' choice to use AAC.

Interaction of rate, quality, response effort, and immediacy of reinforcement. Thus far, the four components of response efficiency have been discussed in isolation. However, rate of reinforcement, quality of reinforcement, response effort, and immediacy of reinforcement may interact to effect the probability that an individual will choose one behavior over another (McDowell, 1988). Thus, an AT user's role may be to analyze the interaction between a particular situation and the efficiency variables to determine the most efficient response.

For example, Johnston et al. (2004) discussed that if an individual is faced with the decision of whether to use a natural gesture (e.g., point to request) or compose a message using a voice output communication aid (VOCA) in a noisy environment, the individual may choose to use the VOCA even though its use requires more response effort than the natural gesture. This choice may seem inconsistent with selecting a behavior that requires the least physical effort. However, given the noise level of this environment, it may be difficult to obtain the attention of the communication partner via a natural gesture. This, in turn, will jeopardize the rate, quality, and immediacy of reinforcement provided for the natural gesture. In contrast, the VOCA will enable the user to simultaneously obtain the attention of the communication partner as well as emit the communicative request. This may decrease the time between the learner's communicative utterance and the listener's response. As a result, even though the response effort associated with the use of the VOCA is greater than that of the natural gesture, the combined advantage of the use of the VOCA across the parameters of rate, quality, and immediacy may outweigh the disadvantage associated with effort.

Role of Response Efficiency in Meeting the Needs of Significant Others

In addition to considering response efficiency from the AT user's perspective it may also be important to consider response efficiency from the perspective of significant others. Numerous investigators have stated that programs will only be effective if the issues of significant others (e.g., family members) have been considered (Brotherson & Cook, 1996; Brinker, Seifer, & Sameroff, 1994; Gallimore, Weisner, Bernheimer, Guthrie, & Nihira; 1993).

In a study by Brotherson, Oakland, Secrist-Mertz, Lithchfield, & Larson (1995), parents who made the decision to use a gastrostomy tube for their child reported that they were faced with a difficult situation. Although the feeding tube meant adequate nutrition, reduced illnesses, and increased opportunities for interactions for their child; it also meant fewer extended family members who would assist with feeding, increased family isolation, and increased financial stress. Thus, in this situation, family members experienced an increase in their response effort in order to achieve an increase in quality of reinforcement for their child.

Examining the role of efficiency from the perspective of both the AT user and significant others will increase the likelihood of creating a contextual fit (Johnston et al., 2004). Contextual fit refers the congruence between an intervention, the individual that the intervention was designed for, and the individual's physical and social environment (Albin, Lucyshyn, Horner, & Flannery, 1996). Contextual fit is particularly important for AT interventions because many uses of AT occur in the context of social interactions. Thus, in order to be successful, the AT user's interactions must be deemed efficient from the perspective of the AT user *as well as* from the perspective of the individuals who interact with the AT user.

Designing Interventions with Response Efficiency in Mind

The components of matching theory can be used when developing interventions involving AT. The interventions can be designed by examining the role of response efficiency for the AT user and/or the significant others. For example, consider the following scenario in which the components of matching theory are manipulated to influence the choice behavior of an AT user. In this situation, interventionists are teaching a preschool learner, Josh, to independently access desired objects in his environment during free choice activities. Currently, Josh will move himself to different classroom areas, but requests the assistance of teachers (via eye gaze and vocalization) to help him interact with desired objects. As discussed by Mace and Roberts (1993), the first step involved in incorporating the components of matching theory into an intervention involves collecting information on the efficiency of Josh's current behavior. Figure 1 summarizes information about the four factors effecting efficiency that was collected via direct observation of Josh in his preschool setting.

Figure 1.
Rate of reinforcement, quality of reinforcement, immediacy of reinforcement and response effort for current method of communication and for the intervention condition.

Factor Influencing Efficiency	Current System	Intervention Condition
Rate of R+	Josh's teachers don't always see/hear his request for assistance to activate desired object. As a result, he is currently reinforced for only 60% of his attempts to interact with toys.	Ensure that the equipment and switches are properly set up so that Josh is reinforced for 90-100% of his attempts to interact.
Quality of R+	If Josh's teachers see/hear him, he receives assistance 100% of the time. Therefore, the quality of reinforcement provided for Josh's current behavior is high.	Provide an equal quality of reinforcement for the new behavior as the old behavior by having the switches consistently activate the desired objects.
Response Effort	The extent of Josh's physical disabilities makes it difficult for him to vocalize with sufficient volume to be heard. As a result, the response effort for Josh to request assistance to activate toys is high.	Have the switches and electronic devices placed in a location to ensure low response effort for the new behavior.
Immediacy of R+	Sometimes the teachers are involved in other activities when Josh wants to activate toys. The teacher's responses aren't always immediate (average latency of teacher's responses is 60 seconds).	Ensure that the equipment is properly set up to allow for consistent and immediate activation of the toy so the latency of response is less than that of the current behavior.

After obtaining information regarding the efficiency of current behaviors, the second step in the process is to formulate an intervention procedure (in this situation, the interventionists are considering teaching Josh to depress a switch in order to activate toys such as a tape player, an electric train, and a battery operated robot) that competes with the current behavior across the four components of matching theory. Figure 1 illustrates how the interventionists adjusted the rate of reinforcement, quality of reinforcement, immediacy of reinforcement, and response effort for the treatment condition. This figure reveals that the adjustments made by the interventionist result in the treatment condition receiving a (a) higher rate of reinforcement, (b) more immediate reinforcement, (c) lower response effort, and (d) an equal quality of reinforcement. This will increase the probability that Josh will choose to emit the target behavior over his current strategy of requesting assistance to access desired objects.

In conclusion, it may be feasible to manipulate various parameters (e.g., rate of reinforcement, immediacy of reinforcement, response effort, quality of reinforcement) in order to alter an AT user's and/or a significant other's choice behavior. This, in turn, has the potential to increase the overall efficiency and effectiveness of AT interventions. However, to date, interventionists are forced to rely primarily on extrapolation in order to speculate on the applicability of matching theory to choice behaviors regarding the use of AT. This extrapolation may or may not be accurate. Therefore, empirical investigations are necessary in order to validate the applicability of matching theory to AT. Research in this area should examine the influence of: (a) rate of reinforcement, (b) quality of reinforcement, (c) immediacy of reinforcement, (d) response effort, and (e) the interaction among each of these components on an AT user's and significant other's choice to use AT. Additionally, research should investigate the most efficient way to incorporate the four components of matching theory into interventions in order to increase their ultimate effectiveness.

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Susan S. Johnston is Associate Professor in the Department of Special Education at University of Utah. Joanna Evans is a doctoral student in the Department of Special Education at University of Utah. Address correspondence concerning this article to Susan S. Johnston, Department of Special Education, University of Utah, 221 Milton Bennion Hall, Salt Lake City, UT, 84112. Email: Johnst_s@ed.utah.edu.

Collaboration is Key: How a Community of Practice Promotes Technology Integration

Judith Zorfass
Heather Keefe Rivero
Education Development Center, Inc.

This article discusses how one professional development program (STAR Tech) used communities of practice to help teachers help each other integrate technology tools into the curriculum to benefit students with and without disabilities. This case study focused on the experience of one team member, a third grade teacher of an inclusive classroom. The study provides evidence that a community of practice promoted technology integration.

Wenger defined communities of practice as "groups of people who share a concern or a passion for something they do and who interact regularly to learn how to do it better" (http://www.ewenger.com/theory/). Beginning in the business world, communities of practice have been found to help employees manage change, access new knowledge, build trust, develop a sense of common purpose, generate new knowledge, and decrease the learning curve for new employees (Wenger & Snyder, 2000). Migrating to the field of education, the term communities of practice is being used to describe schools in which staff members provide meaningful and sustained assistance to one another to improve teaching and student learning (Sparks, 2002). Here practitioners come together to study, put into practice what they are learning, and share results (Joyce & Showers, 2002). Findings are starting to accumulate about the value of *communities of practice* in education. For example, Grossman, Wineburg, and Woolworth (2001) found that when secondary English (ELA), social studies, special education, and English second language (ESL) teachers met regularly over a 2 1/2 year period, they learned new content related to history and literature, as well as new ways of thinking about their subject matter.

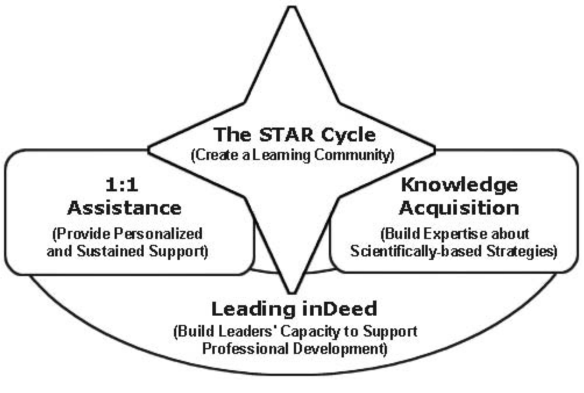
In what ways can a community of practice foster technology integration to benefit students with and without disabilities? Education Development Center, Inc. (EDC) addressed this question during 5 years (i.e., 1997 to 2003) with funding from the U.S. Department of Education, Office of Special Education Programs. In collaboration with schools in Boston, New York, and New Mexico, EDC developed and tested the professional development program named, STAR Tech: Supporting Teachers to Achieve Results by Integrating Technology into the Curriculum. STAR Tech's four interrelated components, as shown in Figure 1, include three professional development components (The STAR Cycle, 1:1 Assistance, and Knowledge Acquisition) and a leadership component.

Overview of the Four Components

The four components of STAR Tech align with the three standards for staff development proposed by the National Staff Development Council (1998).

1. Setting a strong context for professional development: Together, district-level and school-based leaders set goals, address logistical issues, provide teachers with ongoing support and resources, gather formative data, assess impact, and plan for scale-up.
2. Using a range of processes that support adult learning: Forming a community of practice to address teachers' genuine concerns and promote change at the classroom level; engaging teachers in varied activities to expand knowledge of scientifically-based instructional strategies and technology tools; and providing teachers with individualized assistance for translating instructional strategies and technology use into practice.

Figure 1. The four components of the STAR Tech Program.



3. Making sure the content includes building knowledge and skills that are directly relevant to the needs and concerns of those involved: Focusing on improving curriculum, instruction, and assessment by integrating technology tools into scientifically-based instructional strategies.

The STAR Cycle

The STAR Cycle is deliberately placed at the center of the graphic (in Figure 1) to emphasize that a community of practice is at the core of the program. The STAR Cycle brings together general education, special education, technology, and curriculum teachers and specialists who share expertise about a topic, interact on an ongoing basis to further their learning, and over time build a shared body of knowledge. To guide the work of the group, the STAR Cycle relies on an expanded version of the *looking at student* work process (LASW).

1:1 Assistance

The purpose of 1:1 Assistance is for teachers to have personalized and sustained assistance from an expert (e.g., an external or internal change agent, a staff developer, a technology/media or curriculum specialist, a special educator, or another teacher) to translate into action technology-based ideas generated within the community of practice. This component responds to the finding that "teachers really need in-depth, sustained assistance as they work to integrate computer use into the curriculum and confront the tension between traditional methods of instruction and new pedagogic methods that make extensive use of technology" (The CEO Forum, 1999, p. 11). Teachers need help in understanding the features of a particular high tech tool, determining how it aligns with the curriculum, learning how to operate it, and figuring out the logistics of its use (i.e., when, where, and with which students) (Woodward and Cuban, 2001).

Knowledge Acquisition

This component was designed to deepen teachers' content knowledge and pedagogy, understand the complexity of a subject, and know when a practice can or cannot promote student learning (Bransford, Brown, & Cocking, 1999). Knowledge Acquisition strengthens a community of practice by helping members to notice more when they examine student work, make more insightful interpretations, and offer more productive strategies for instruction and assessment. When teachers have expertise about scientifically-based strategies, their exploration about how to integrate technology is more likely to begin with a grounding in effective practice. Activities to deepen knowledge might include, for example, attending workshops, having experts join team meetings, seeing demonstrations, observing classrooms, and reading and discussing articles.

Leadership

To support the successful implementation of its three professional development components, STAR Tech builds the capacity of leaders in two ways. First, it identifies key leaders at the district and school levels in curriculum, special education, and technology. One leader assumes the role of champion, advocating for STAR Tech and shepherding the implementation process by working closely with principals and school-based team facilitators. A comprehensive set of guidelines, called *Leading inDeed*, steers leaders through a multi-phase implementation process that involves exploration and decision-making, start-up, implementation, formative evaluation, summative evaluation, and scale-up.

The purpose of this article is to show how the STAR Cycle creates a community of practice and what is its impact on component teaching. The first half describes the STAR Cycle in depth, relying heavily on the experiences of Graciela, a relatively new third grade teacher in Brooklyn, New York. In fact, it is Graciela who deserves credit for the title, telling us repeatedly that "collaboration is key." The children in Graciela's inclusive class came from many diverse backgrounds (e.g., recent immigrants, students with disabilities, second language learners). Most struggled with all aspects of literacy development, as evidenced by their low standardized test scores. In the second half of the article, we shift gears to focus on the value of the STAR Cycle in fostering technology integration. For this section, we turn to stories of collaboration from a small, but highly diverse school in Boston, Massachusetts, that has both inclusive classrooms and substantially separate classes for students with severe disabilities. The cases were chosen because they are representative of the work of schools and teachers across our districts, including not only the schools we worked with during five years of federally-funded research, but also afterwards, when we consulted to school districts to support the implementation of STAR Tech.

A Community of Practice in Action

The obvious prerequisite for building communities of practice is to form working groups. In the STAR Cycle, collaborative groups typically include approximately seven teachers and specialists, drawn from general education, special education, curriculum areas, technology, and as relevant, ESL and the related arts. In some districts, elementary school teams have cut across the grades (e.g., K-1, 2-3, and 4-5). At the middle-grades level, teams have been organized both by discipline (within and across grades) and interdisciplinary teams. In high schools, teams have usually been organized by department. Some districts have organized the entire faculty (K-12) into teams; others have focused on the elementary grades.

Led by a facilitator (e.g., a staff developer, specialist, teacher, or administrator), STAR Cycle teams meet on a regular basis—perhaps every other week, every third week, or once a month. They can meet before, during, or after school, depending on the school schedule, culture, incentives, and preferences of the team members. Most importantly, however, is that meetings last at least 45 minutes to ensure a productive session.

When the STAR Cycle was implemented at Graciela's school in Brooklyn, the team included one general education teacher from each of grades 2, 3, and 4; a special education supervisor and a special education teacher; a technology specialist; and the principal and assistant principal. The team met every other week from October through May for 90 minutes each time. The principal and assistant principal, who both placed a high priority on creating a learning community, arranged for substitutes to cover the teachers' classrooms if they did not have a preparation period.

It is important for the work of the learning community to be aligned with the school improvement plans and key initiatives based on findings from a needs assessment. For example, administrators might survey teachers and examine student data to identify the key areas of curriculum-based needs. With a focus on technology, they might inventory available technology tools, as well as teacher experience and comfort level with technology integration. By anchoring the work of the community in an authentic need, concern, or question, the sense of purpose becomes both explicit and shared by the participants. At Graciela's school, the concern focused on raising low achievement test scores in English language arts. Given that a technology specialist had recently joined the faculty at beginning of the school year, the staff had hopes of increasing their technology use in the classroom, since most had been using available resources on a very limited basis.

The STAR Cycle Process

The STAR Cycle was so named because it creates a cycle of collaborative team discussion, individual teacher application in the classroom, and reflection (first individually and then with the team). What anchors the team discussion is LASW.

LASW is a promising strategy for supporting rich and productive collaboration among practitioners (Little, Gearhart, Curry, and Kafka, 2003). Its varied history stems from work at Harvard's Project Zero, the Coalition of Essential Schools, the Annenberg Institute for School Reform, and our own organization, EDC (Dunne, 2000). According to Joan Richardson (2001):

> *Examining student work helps teachers intimately understand how state and local standards apply to their teaching practice and to student work. Teachers are able to think more deeply about their teaching and what students are learning. As they see what students produce in response to their assignments, they can see the successes as well as the situations where there are gaps. In exploring those gaps, they can improve their practices in order to reach all students (http://www.nsdc.org/library/results/res2-01rich.html).*

STAR Tech's version of LASW is similar to other frequently used versions (Blythe, Allen & Powell, 1999) in the following ways: a facilitator guides the conversation, a presenting teacher shares a genuine concern, the group uses a protocol to guide its work, student work is carefully examined, and a volunteer records the conversation. Two features, however, distinguish our approach. First, the presenting teacher brings the work of three diverse students instead of one (i.e., a typical student, a student who is struggling, and a student with disabilities who has an IEP) to serve as a proxy for the diversity in the classroom. Second, there is explicit attention given to integrating technology into the discussion of instructional strategies.

The STAR Cycle captures what happens inside the team meetings and also goes beyond the in-team discussions to include application back in the classroom and reflection. Each letter in the word STAR serves as a mnemonic to make the ongoing process within the STAR cycle explicit.

1. S (Set the Context)—For each meeting, a teacher volunteers to be the presenting teacher who launches the conversation by introducing three focal students and an instructional need.
2. T (Teamwork)—At the team meeting, teachers examine the student work, make objective comments, make interpretations, generate instructional strategies that integrate technology tools, and plan to apply strategies in the classroom.
3. A (Apply Strategies)—Back in the classroom, teachers carry out their plans for applying instructional strategies and technology tools, often with help from experts and colleagues.
4. R (Reflect on Results)—After teachers apply strategies, they reflect on the results (e.g., How did the strategies and technology tools help students?). At the next team meeting, they share their reflections.

For each step in the process, the facilitator and teachers rely on a set of tools to guide and document the ongoing collaborative process: the protocol; LASW Record Sheet, Set the Context Tool, Apply Strategies Tool, and Reflect on Results Tool. The complete set of tools is included in the Appendix. Each step of the cycle is described in more detail.

Set the context. A presenting teacher shares an authentic, classroom-based concern about teaching and learning, the prerequisite for meaningful technology integration (Zorfass, 2001). The first time that Graciela volunteered to be the presenting teacher, she arrived at the conference room early, along with the team facilitator. Before the other team members arrived, Graciela placed a filled out version of the Set the Context Tool with an attached packet of student work on each team member's seat. After the facilitator convened the meeting, she asked Graciela to set the context. Referring to her handout, Graciela did the following:

1. Described the abilities and needs of three focal students who represented a range of learner differences. For example, one student, the typical student, "was making good progress as a reader, but needed help as a developing writer." A second student was at risk, particularly because of "difficulties in producing text." The student with disabilities "demonstrated serious difficulties in writing, even at a basic level of sentence structure."
2. Described her narrative writing assignment. "After writing a first draft, I did a mini-lesson on general vs. specific words. Then I asked the class to revise their drafts."
3. Identified her curriculum goal. "Have students 'show and not tell' by using detail in their writing."
4. Stated her guiding questions. "How can I encourage my students to add detail and help them organize their writing better? How can I help my students take more risks with their writing?"
5. Referred the team to the three work samples she had distributed.

Teamwork. The next part of the protocol begin with each team member silently examining the three pieces of student work for several minutes. Then the facilitator asks them to make objective comments, noticing exactly what was in the work that could be documented. The facilitator reminds them to use phrases such as "I can see," "I note," "Here is," or "There is" as they begin each comment. The purpose is to take note of elements or aspects of the students' work. What typically happens is that teachers find evidence of both strengths and weaknesses in all three samples of the focal students' work.

In Graciela's team, after silently observing the work for five minutes, the facilitator asked members to share their observations. Starting with the typical student, they considered each work sample individually. Although the teachers discussed both weaknesses and strengths, they tended to look for the positive in each student's work. For example, one teacher said, " I note a sense of suspense in the typical student's work. The typical student creates a sense of suspense." Another said, "I see lots of details in the at-risk student's writing. The at-risk student uses lots of details." The principal, with a strong ELA background observed that, "the student with disabilities followed a typical progression of a story, appropriate for grade level." This step helped lay a foundation for generating strategies that build on students' abilities.

Continuing to follow the protocol, the facilitator then asks the team members to go beyond the objective description of the work to make interpretations. Interpretations focus on why something is happening, what the student might be trying to do, or what factors could have helped or hindered each student's performance. The facilitator reminds team members that their interpretations should relate to the presenting teacher's curriculum goals and guiding question.

When Graciela's team members finished making their observations, the facilitator asked them to share their interpretations about what they had seen in the work, keeping in mind Graciela's guiding questions. In the ensuing conversation, one teacher noted that the typical student did not take any risks in writing—just used short sentences. "Maybe her goal is to be correct, not to challenge herself." Graciela agreed that she recognized this about the student. She added, however, "this student is inclined to try something new if she sees it modeled first in a book." Graciela reported observing the student using this technique. In terms of the student with disabilities, one teacher thought that the student appeared to be struggling with making a transition to English from Spanish.

The three previous steps—(a) silently examining the work, (b) making objective comments, and (c) making interpretations—all lay the groundwork for generating instructional strategies that can enhance learning. The facilitator asks two prompting questions: "If the presenting teacher was going to work towards similar goals in another lesson, what might she do differently? What did we see in this round of student work that can help us develop strategies for other similar lessons?" The facilitator also asks the team to draw upon the scientifically-based strategies they have been learning about through their knowledge acquisition activities. The facilitator encourages teachers to consider ways in which low, mid, and high tech tools could be integrated into these strategies to meet the needs of all learners in the class in accordance with the principles of universal design for learning (Rose & Meyer, 2002).

After Graciela's team discussed their interpretations, they were eager to share their suggestions for instructional strategies. The fourth-grade teacher started off the discussion by recommending a strategy to help the typical student take risks in her writing. He suggested that Graciela "point out examples of students taking risks in their writing and commend them for doing so even if they did not get it quite right." Another teacher added, "If the typical student came to understand that experimentation is a worthwhile part of the writing process, she might become less critical of her own mistakes and freer with her writing." Other suggestions included using graphic organizers to help students organize ideas and add details, pairing students with more advanced writers, grouping gifted writers together to focus on the author's craft, using the work of good writers as examples for mini-lessons, and having student partners conduct a peer conference while other students observe and later debrief.

The team's recommendations embedded various technology tools. For example, two low tech solutions included (a) having students use highlighter tape to pick out important topics that they could expand on later and (b) using a transparency to reproduce and cut students' work into strips, giving them room to add details. In terms of high tech solutions, someone suggested conducting a class activity in the lab using Kidspiration (2000) to map out and develop the story. Someone else recommended using Co:Writer (2000) or *Write:OutLoud* (1993-1998) with ESL students.

Apply Strategies. Before the team meeting ends, the facilitator follows the protocol for applying strategies by turning to the presenting teacher with the following question: "Have you heard any ideas during the discussion that you are interested in trying back in your classroom?" The facilitator asks the volunteer recorder to read back the ideas that were documented on the LASW record. As the presenting teacher mentions each suggestion, the facilitator asks what kind of help the teacher might need to actually implement the idea. This prompt creates an opportunity for another teacher, a technology expert, and/or a staff developer to offer help, which naturally embeds the 1:1 Assistance component into the community of practice.

Following the protocol, the facilitator asked the recorder to read back all of the suggestions. Graciela responded by saying, "Since I already use printed graphic organizers with my students, I would like to learn more about how to work with my students on the computer." Matt, the technology specialist, offered to help her explore the program Kidspiration after the meeting.

However, in the STAR cycle, the presenting teacher is not the only one expected to apply strategies. The goal is for as many teachers as possible to make a public commitment to try something out in their classroom. Sometimes, the facilitator does a round-robin, asking participants what they heard that was relevant for their teaching. This is the time to ask for and make arrangements for help from teachers and specialists with particular areas of technology expertise. To document plans, the facilitator hands each teacher the Apply Strategies Tool.

Graciela had the advantage of individualized assistance later on the same day to begin applying strategies discussed at the meeting. With a substitute covering her class, she spent two hours exploring *Kidspiration* in the computer lab with Matt. He gave an overview and demonstration of the program's capabilities and then showed Graciela some examples in the Kidspiration activity folder, which is included with the software. For example, she showed Graciela how she could use the program to make a variety of symbols, label them with ideas, and link them together to form a web. Matt also opened up the Inspiration/Kidspiration Web site, which had several sample activities and suggestions for use in a variety of curriculum areas. Then Matt walked Graciela through some of the operations, telling her the steps to follow. Being a fairly comfortable computer user, Graciela learned the new skills quickly.

Graciela was very excited about the program and brainstormed several ways she could use it for writing activities with her students. "I like the idea of having my students organize their ideas visually because it could help them understand patterns and relationships between concepts." She could also see how it would stimulate creative thinking. "Maybe I'll start with a character map to help my students pull out important information from their reading and become more aware of specific details."

Matt showed Graciela how to access the program's large collection of templates and modify them for her own use. Graciela then opened an example that had a diagram for character analysis and revised it for *Charlie and the Chocolate Factory* (Dahl, 1964), a book her class was reading (see Figure 2).

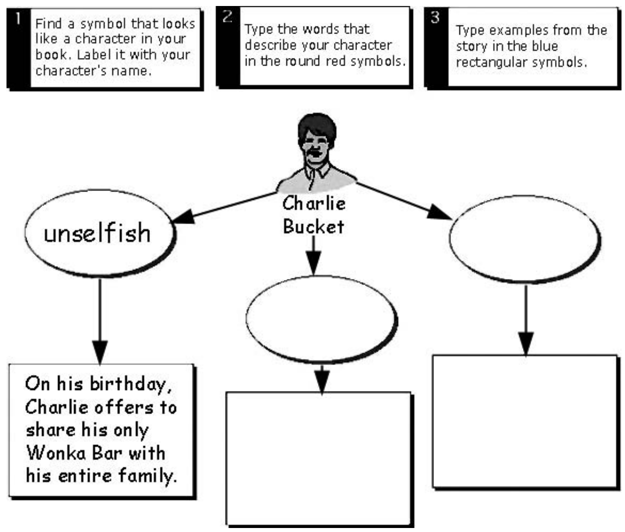
Matt brainstormed ways in which Graciela's class could begin using the program. Graciela decided to start by printing out the diagrams on transparencies so that she could project them on the wall for her students. She thought this strategy would acclimate her students to working with graphic organizers, "giving them a better sense of how they were constructed before going to the computer lab." Matt offered to do a *Kidspiration* training session with the entire class once Graciela felt they were ready. Graciela hoped to have students start on the computer by filling in graphic organizers (such as the character analysis) that she had created for them. Once they had more understanding of the concepts and had become fluent with the program, Graciela planned to "move on to having them create their own organizers."

Reflect on Results. Following the protocol, the next team meeting begins with the presenting teacher and others reflecting on results. When her team met again, Graciela described what happened when she had integrated *Kidspiration* into her writing assignment:

> *I printed the graphic organizer that I had created when working with Matt and then photocopied it onto a transparency. I read a chapter from Charlie and the Chocolate Factory aloud to the whole class. Then I projected the character analysis graphic organizer using an overhead projector. I engaged the class in a brainstorming activity, inviting the students to tell me what content to fill in for each of the areas. Later, during independent reading time, I gave students similar graphic organizers (blank and printed on paper) to fill out as they did their reading. Later, when students were beginning*

their draft writing, I asked them to organize their ideas into main ideas with supporting details.

Figure 2. Graphic organizer for Charlie and the Chocolate Factory.



Graciela commented that this activity made her realize "that when the students are struggling, you really have to break it down for them." She was pleased with the results of using the template for a group brainstorming session. "It helped my students generate more interesting ideas for writing. It also gave them a basis for identifying and then using specific details to support their main idea."

How the STAR Cycle Promotes Technology Integration

The STAR Cycle builds a social learning system—the hallmark of a community of practice. Across schools, we found that this ongoing, collaborative process helped strengthen teachers' capabilities in ways that promoted technology use as a meaningful part of the instructional process. To provide specific examples of teacher change, we head north from Graciela's school in Brooklyn, New York to a small, highly diverse, K-5 elementary school in Boston, Massachusetts. This school decided to implement the STAR Cycle as a way to strengthen its Balanced Early Literacy (BEL) program, which was being used to improve reading and writing for all students, including those with and without disabilities. Since the STAR Cycle was aligned with their major literacy initiative, the teachers had a shared repertoire of ways of doing things from the outset (Wenger, 1999), which further contributed to community building and a sense of shared responsibility (Wagner, 2001). An analysis of field notes from observations of STAR Cycle meetings in Boston, group and individual interviews, and surveys and feedback forms, revealed that the STAR Cycle process fostered technology integration in two important ways:

1. Teachers gained insights from each other about their students' abilities and needs. This information in turn, helped them make better decisions about instructional process and the role that technology can play.
2. When suggestions and recommendations for integrating technology into the curriculum came from colleagues who understood each others' curriculum goals and students' needs, teachers were motivated to try new strategies in their classrooms.

Teachers Gained Insights about Students

The analysis of students' abilities and needs is interwoven throughout the STAR Cycle process. When setting the context, the presenting teacher briefly highlights the abilities and needs of the three focal students. Many teachers told us that preparing to be a presenting teacher "helped me to look more closely at my students' differences." When colleagues made observations, they noticed both strengths and weaknesses in each student's work. Not only the presenting teacher, but the others on the team as well, felt that this double-barreled approach helped them to better understand what a student could and could not do, what strengths to draw upon in planning instruction, and what areas to emphasize for re-teaching, remediation, and refocusing. Typical comments included:

1. "Helped me to recognize different needs better—e.g., behavior problems, challenged learners, and fast learners—and then tailor lesson plans to the variety of learning styles."
2. "Helped me to isolate students' needs at the keyboard and work out a variety of technical problems."
3. "Opened my eyes to difficulties my students present with outside of my discipline."
4. "I am more aware that we have students with many individual needs."
5. "I make more detailed and accurate assessments because when I made my presentations, I had to really focus on the specific child."

Both general education and special education teachers developed insights about student diversity. Two representative examples in Boston came from Janey (special education teacher) and Jessica (kindergarten teacher).

Janey. Janey, a special education teacher of upper elementary school students with severe cognitive and behavioral difficulties, found that the team meetings helped her to better identify her students' strengths. She once brought to a team meeting the work of a student who she had expected to be further along in his writing. "I was accustomed to focusing on what the student couldn't do—on his poor writing skills. But during the time when teachers make objective comments after studying the work, another teacher pointed out that the student, in fact, included a lot of information." Janey said that the exchange during the meeting gave her a new perspective. "I didn't look at it that way. I was looking at where he needs to be… I went back afterwards to my classroom and said, you know, she's right." Re-evaluating the situation, she came to realize that "What I got wasn't what I was expecting. But I got some great stuff… Isn't it interesting that this child did this, even though I expected more?" In contrast to overlooking a student's strength, in another situation Janey felt she overlooked a different child's need. She had not noticed, until a colleague pointed it out, that the child's writing sample lacked details in writing a paragraph. As described later, Janey used this information when she later planned an ELA unit on autobiographies that integrated the application, *iMovie* (1999).

Jessica. A relatively new kindergarten teacher, Jessica volunteered several times to be the presenting teacher because she trusted and relied on her colleagues' insights. She noted that through these successive sessions, she became much better at looking at each student individually. She explained:

> *[It helps me] going through and noticing what you see about each student and then inferring about each student instead of lumping them together. Because I do think you really need to look at their individual work and then come up with the strategies . . . There are so many things you can notice and infer from looking at student work. It's sort of opened my eyes.*

Once teachers opened their eyes about the three focal students, they would go back to the classroom and look more closely at the work of other students. Many teachers reported that, "I varied my teaching strategies," "I tried new ideas," or "I grouped students differently." One said that she "relies less on testing and more on observation." The value of better understanding students' diverse abilities and needs is that teachers find themselves more able to finely tune the instructional process and make better instructional decisions (e.g., "I focused on certain techniques and developed plans to address students' needs"). Teachers reported that by examining the work of three diverse students, they were better able to understand the range of students' needs (e.g., "I feel that LASW is an extension of the inclusion model." My practice, my colleagues' practices, and student performance have all improved."). For many teachers, these insights about students laid the foundation for trying out practices that integrated a variety of technology tools.

Teachers Changed Practice

Within the team meetings, the LASW protocol was designed to guide conversation from looking at work, to generating strategies, to making technology suggestions, to planning to apply strategies and tools in the classroom. Then, after the meetings, the collaborative cycle encouraged teachers to apply new ideas and reflect on how effectively they worked for students. The teachers in Boston reported that they (a) came to rely on their colleagues suggestions (e.g., "If it worked for them, it can work for me,"), (b) trusted their colleagues because they "understand my situation," and (c) valued their colleagues' willingness to help (e.g., "After the meeting, she found and lent me the software program mentioned during the meeting.").

Jessica. Jessica posed a question at the team meeting about how to improve interactive writing, one of the strategies required in BEL's program. What emerged during the meeting was her hesitancy, as a new kindergarten teacher, to introduce high-frequency sight words to her students. She reasoned, "If I introduced all of those words, then the kids who were struggling would just be lost." So she had decided to hold back. She recalled that at the team meeting, the other teachers noticed that her students did not have specific high-frequency words. Her colleagues encouraged her to explicitly teach these words to all students, using low and mid tech tools to help. For example, they suggested putting sight words on cards, giving each child a set of cards with these words, and having students fill in the last word of a sentence that started with, "I am a…" They also talked about how tape recorders and AlphaSmart keyboard devices could be used. Her colleagues' genuine concern motivated Jessica to immediately start imagining how she could translate these ideas into practice in her writing center. Based on their suggestions, she later reported using a visual matching game, highlighting more of the words that were posted in the room, circling words in print, having students write the words, and using magnetic letters. She found that these low tech strategies worked better than expected. "Many of the kids have a number of high frequency words that they can read and write."

Richard. As a fourth grade teacher, Richard was concerned about how to help his students unpack their ideas into separate paragraphs, each about a different idea. During a STAR Cycle meeting, his colleagues suggested a way to vary the BEL strategy of interactive or shared writing by using a common mid tech tool—the overhead projector. Back in his classroom, Richard immediately decided to apply the ideas. He selected the work of the student who exhibited the most difficulty in creating paragraphs. In a recent writing assignment, this student's essay had been one long paragraph with five big ideas jumbled together. The text begged to be divided into five separate paragraphs. Richard asked the student if he would mind having his essay used as a stimulus for group editing. The student agreed, saying he "felt fine about it" (especially because he expected to get a finished product out of the experience). Richard decided to correct the spelling errors before showing the paper to the class because he wanted the class to focus on the content, not the spelling.

Richard reproduced the student's writing and displayed it on a large screen. He gathered together everyone in the front of the room. After they had a chance to read the draft, Richard "asked the class to identify where they saw the author's thoughts changing." He said that they could use this shift in ideas as a marker for another paragraph. He began by asking, "Where do the new paragraphs start?" He then made notations on the overhead transparency. After 15 minutes of brainstorming, the students returned to revising their own drafts, some on and some off the computer. After using this strategy again during another writing session, coupled with other strategies aimed at promoting paragraph structure (e.g., using sticky notes), Richard found that his students were showing marked improvement. "They pretty much have mastered the concept of paragraphing," he told his team at the next month's meeting.

Vicky. Vicky taught a primary transition classroom that offered students an extra year between kindergarten and first grade. She was interested in helping her students develop their writing skills. At a STAR Cycle team meeting, one teacher suggested using *PixWriter* (Slater & Slater, 1998-2000), a word processing program that uses graphics to give struggling and emergent writers visual and auditory support/feedback as they compose. The user can type just as he or she would on an ordinary word processor. As the word appears on the screen, a corresponding picture pops up above the word. It also speaks the word out loud. One of the most important features of *PixWriter* is that it allows teachers to create set-ups for students. Simply by typing words on the keyboard, an array of buttons with the words and symbols is created at the bottom of the screen. This allows students to create stories just by selecting these buttons (somewhat like a digital communication board). Teachers can save a variety of set-ups for different students and subjects. Vicky liked this process and wanted to try it in her classroom.

Based on ideas generated at the team meeting, Vicky was able to create five connected activities that spanned several days. On the first day, she asked the students to brainstorm what they knew about the ocean. She wrote their ideas on the board and then placed the ideas on sticky notes as had been suggested at the team meeting. The second activity involved having students form sentences using word cards. Each card had a word and a picture or icon on it. The students arranged the words/pictures into a sentence and pasted them onto a blank piece of paper. In the third activity, the students typed the sentences using PixWriter with picture cues. Building on this, in the fourth activity, they used the "type tool" in *Kid Pix* (1994-1998) to compose sentences without pictures. Finally, in the fifth activity, the students wrote their own sentences (at least two) by hand, while retrieving sticky notes with key words and referring to the word card. Vicki was delighted with the results. Every student was able to compose at least two meaningful sentences.

Chris. Chris taught a class of 12 young primary school students. All had language processing delays and cognitive disabilities, and four had autistic tendencies. Varying the protocol, Chris asked her team to help her focus on the needs of one student, Christian. While he was nonverbal at school, his parents reported that he spoke Spanish at home like the rest of the family, and the paraprofessional reported that he had communicated in both English and Spanish the year before. Chris told the team, "He seems to comprehend what I say to him in class, enthusiastically participates in classroom activities, communicates mostly through movement, has limited writing ability, and draws very well." Her team's suggestions led Chris to make a communication wallet for Christian using BoardMaker (King, 1994), which has numerous symbols for creating a communication board. By pointing to the symbols contained within his wallet, Christian could communicate with his teacher and classmates. In addition to creating the communication wallet, she followed the recommendations in the BEL Program by placing symbols along with the corresponding words throughout the room next to the corresponding objects. Chris noted that the BoardMaker symbols not only helped her nonverbal student communicate better, but they also helped many of her students begin to make stronger word/symbol connections.

Gradually, Chris found other ways to integrate BoardMaker into her emergent literacy curriculum. She began using the BoardMaker symbols as visual enhancements for the writing prompts she gave to all of her students. For example, on the writing center wall Chris displayed the prompt, "Which would you want to be: A Bird or A Fish?" She used the symbols for bird and fish to help students understand the prompt better. She also used BoardMaker symbols to write out the recipe when the class made gingerbread men.

Janey. At a STAR Cycle team meeting, Janey became intrigued when Richard described how he was using iMovie with his fourth-grade students to produce lively autobiographies that combined text, music, and pictures. Janey became interested in doing something similar with her students to meet her district's ELA standards for language, literature, and composition. Janey's six male students, ranging in age from 9 to 12, were easily distracted and required a great deal of individual attention to complete tasks. All had difficulty with word recognition and reading comprehension, as well as in expressing their ideas orally and in writing. Setting high expectations, Janey's motto was, "I have never met a child who I could not teach." She reasoned aloud to her colleagues that the technology could motivate students to persevere through the writing, revising, publishing, and viewing process. Past experience revealed that her students exhibited an aptitude for using high technology tools, such as Microsoft Word, Excel, Inspiration (1998-2000), and TimeLiner (1995-2001). They were also familiar with the concepts of biography and autobiography, having read and written in these genres.

Richard offered to help Janey implement her autobiography pilot unit at the end of the school year as the final project. Using iMovie, the students created autobiographies with photos of events, people, and places; stories related to the pictures; and even a musical score. They were thrilled to have an opportunity to experiment with new media. Janey was impressed with the quality of the writing the students produced and their level of focus and commitment to completing the project.

Conclusion: Collaboration is Key

Even though schools have been introducing technology into instruction since the early1980s, almost 2 decades later, when we began our research project in urban schools, we found that technology use for students with and without disabilities was anything but pervasive. While our needs assessment data indicated that teachers spanned the continuum of technology use—entry, adoption, adaptation, appropriation, and invention (Kleiman, 2000)—most fell within the early stages of entry and adoption. It was not uncommon to hear them make comments such as the following:

1. "I am in the process of learning about software programs, such as Co:Writer and eReader (1999). I need lots more time to learn these to use them with my students."
2. "I'm pretty much of a low tech kind of instructor, but with baby steps I know I will get there."

Over time, collaboration helped teachers make slow but sure incremental changes in their use of technology—in ways that met their goals, interests, ability levels, and most importantly, needs of students with and without disabilities. For example, in the Boston school, 85% of the teachers began using low tech (e.g., highlighter tape, magnetic letters), mid-tech (e.g., AlphaSmarts, overhead projectors, and tape recorders), and high-tech tools (e.g., AppleWorks (2000), eReader, Kidspiration, iMovie, KidPix, Pix Writer, Co:Writer, Intellipics (1992), and BoardMaker) alone and in combination.

Echoing Graciela's words, we found that "collaboration is key" in promoting technology integration. Collaboration within a community of practice addresses head-on one of the major barriers to technology integration often discussed by Larry Cuban, a national leader known for charting the course of technology use in schools. Cuban (2003) asserts that one of the prime reasons why teachers do not adopt technology innovations is because technology initiatives are top-down, administrator-driven, lacking the essential element of giving teachers enough of a say in the process.

A community of practice allows teachers to drive classroom change based on genuine concerns, the curriculum goals identified in the standards, and available low, mid, and high tech tools (e.g., "I loved the fact that we focused on technology this year. I learned how to use our scanner, digital cameras, and Smart Board."). Within a community of practice, teachers can share their areas of strength and acquire knowledge to bolster areas of need, and have the support of colleagues to translate ideas into practice (e.g., "I gained confidence to try new ideas."). When the area of need is about integrating technology tools, they have the support of colleagues for generating and then applying ideas. On any given team, the comfort level might be starting with low tech tools (e.g., "My students benefited greatly from new ideas, especially low tech interventions.") or mid and high tech tools (e.g., "I was more willing to use technology such as *Inspiration*, AlphaSmart, and Homework Helper when working with my students."). Even Janey, a long-time and confident technology user, found ways to push her technology envelope further with a complex application—iMovie.

As teachers expanded and deepened their use of technology tools across a classroom, they tended to find ways to benefit students with a range of diverse abilities and disabilities (e.g., "I work with students who have a huge range of abilities and deficits. Programs such as, Kidspiration, Write:Outloud, and Pix Writer address the different kinds of issues my students deal with."). In today's educational context, where all students are expected to meet high standards, teachers are finding value in become collaborative partners in this important endeavor—finding ways together to better understand students, identify curriculum goals, use effective instructional and assessment strategies, and meaningfully integrate technology into this equation for improving student outcomes.

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Judith Zorfass is Associate Center Director and Senior Director of Strategic Planning for the Center for Family, School, and Community (FSC) at Education Development Center, Inc. Heather Keefe Rivero is a research associate in the Center for Family, School, and Community. *This article was written with support from the LINK•US Project, a contract with the U.S. Department of Education, Office of Special Education Programs, under Contract No. HS97022001. The opinions expressed in this article do not necessarily reflect the policy or position of the funding agency, and no official endorsement should be inferred.* *Address correspondence to Judith Zorfass, EDC, 55 Chapel Street, Newton, MA 02458-1060. Email to: jzorfass@edc.org.*

Appendix A-1. The protocol used for the STAR Cycle team meetings.

The STAR Cycle

LASW Protocol (45 minutes)

TASK	SUGGESTED TIME (minutes)
REFLECT ON RESULTS: • Describe instructional strategies and technology tools used since last meeting (3 minutes) • Describe changes in performance (2 minutes)	**5**
SET THE CONTEXT: • Describe focal students (2 minutes) • Describe the lesson (2 minutes) • Identify the standard(s) addressed in the lesson (1/2 minutes) • Pose guiding question to the team (1/2 minutes)	**5**
TEAMWORK: • Observe the work silently (5 minutes) • Discuss observations objectively (6 minutes) • Make interpretations (3 minutes) • Recommend instructional and technology strategies (6 minutes)	**20**
PLAN TO APPLY STRATEGIES: Implementation (8 minutes) • Which students will you target? • What instructional strategies and technology tools will you use? • What supports do you need? Assessment (7 minutes) • Which standards apply? • What changes in performance do you expect to see? • What evidence will you collect? • What criteria will you use for evaluation?	**15**
	TOTAL TIME **45 minutes**

Appendix A-2. The Set the Context Tool to be filled out by the presenting teacher.

The STAR Cycle

Set the Context Tool

Presenting Teacher: **Date of Meeting:**

Student #1

Abilities	**Needs**

Student #2

Abilities	**Needs**

Student #3

Abilities	**Needs**

Lesson Objective

Teacher's Directions for Lesson	**Objectives and Expectations for Lesson/Product**

Standards Addressed	**Teacher's Guiding Question for the Team**

Appendix A-3. The LASW Record Sheet used to document discussions at team meetings.

Recorder:____________________ **The STAR Cycle** Date:____________________

LASW Record

Reflect on Results: Append completed Reflect on Results Tool or record responses below.

Strategies and Technology Tools Tried	Changes in Student Performance Since Last Meeting
Previous Presenting Teacher:	Previous Presenting Teacher:
Other Teachers:	Other Teachers:

Set the Context: Append completed Set the Context Tool or take notes on a blank tool.

Appendix A-3. The LASW Record Sheet used to document discussions at team meetings.

Recorder:________________________

The STAR Cycle

Date:_____________________

LASW Record

Teamwork Presenting Teacher:

Observations ⇩	Interpretations ⇩	Instructional and Technology Strategies ⇩
Student #1	Student #1	Student #1
Student #2	Student #2	Student #2

Appendix A-3. The LASW Record Sheet used to document discussions at team meetings.

Recorder:________________________ **The STAR Cycle** Date:______________________

LASW Record

Teamwork Presenting Teacher:

Observations ⇩	Interpretations ⇩	Instructional and Technology Strategies ⇩
Student #3	**Student #3**	**Student #3**

Plan to Apply Strategies Enter here the strategies that the team members plan to try. Start with the presenting teacher. ⇩

Appendix A-4. The Apply Strategies Tool distributed at the end of the team meeting to help teachers plan for implementation.

The STAR Cycle

Apply Strategies Tool

Implementation	Assessment
✧**Which students will you target?**	✧**Which standards apply?**
✧**What instructional strategies will you use?**	✧**What changes in performance do you expect to see?**
✧**What technology tools will you use?**	✧**What evidence will you collect?**
✧**What supports do you need?**	✧**What criteria will you use for evaluation?**

Name: ______________________ **Date:** ____________

Appendix A-5. The Reflect on Results Tool filled out by teachers to describe classroom implementation.

The STAR Cycle

Reflect on Results Tool

✧ What did you do? With whom? Using what? Why?

✧ How did you assess students? What were your goals? What evidence did you collect? How did you evaluate?

✧ What were the results?

✧ What could you change in the future to improve teaching and learning?

Please attach copies of student work from before and after the use of the new strategy.

Dave Edyburn, Ph.D., University of Wisconsin, Milwaukee

Special Education Technology Networks of Practice

In many professional circles, the research to practice paradigm is unquestioned (Malouf & Schiller, 1995). Nonetheless, communities of practice are increasingly viewed as a valuable source of information and insight about what works. In current discussions about evidence-based practice, we often fail to appreciate that practices, validated by professional judgment, are one form of evidence.

The purpose of this column is to briefly describe the theoretical base for communities of practice and their relevance for learning about special education technology and building the evidence base. Readers will then be introduced to four online networks of practice that support the work of special education technology professionals.

What is a Community of Practice?

In recent years, learning theorists have focused on the social context of learning. In this view, learning is not simply an isolated individual task, rather, learning is facilitated by membership in a community. Learning by doing is essential to the task of building knowledge. As a result, knowledge is inseparable from practice (Communities of Practice, 2005; Shulman, 2004).

Learning has been characterized as having two components: (a) "know that" and (b) "know how" (Ryle, 1949). Learning about a topic in the form of facts, concepts, and principles represents the "know that" component that is commonly associated with expertise. With the explosion of the Web, learning about a topic has never been easier. "Learning about does not, however, produce the ability to put 'know that' into use" (Brown & Duguid, 2002, p. 128). Recognizing the gap between knowledge and practice illustrates the need for the second component of learning, "know how." Practice shapes and supports learning. Researchers have found that by studying communities of practice they are able to explain the many complexities associated with the process of creating shared understanding of what works and how learning can be enhanced or impaired by organizational behavior (Brown & Duguid, 2002, 1991; Smith, 2003).

A community of practice is distinguished by three components: (a) what it is about, (b) how it functions, and (c) what capability it has produced (Smith, 2003; Wenger 1999). It is important to note that the community is a communal enterprise that is subject to ongoing renegotiation of its purpose and function. The shared repertoire of the members provide vocabulary, style, and conventions, that bind participants in a social community that defines engagement.

Brown and Duguid (2002) make a distinction between *networks of practice* and *communities of practice*. Networks of practice "link people to others whom they may never know but who work on similar practices" (p.141). While these systems provide great power through their speed and notable reach across geographical space, network members do not have much personal interaction with each other. As a result, these social systems are characterized as loosely coupled. They are notable for the ability to efficiently share information but produce limited action or new knowledge since the information is assimilated by each individual member of the network. Communities of practice are a "subsection of the larger networks of practice" (pp. 142-143). They are relatively tight-knit groups that benefit from face-to-face communication. The social bonds of group membership in this context produces ideas and knowledge that is distributed across the group and fosters collaborative and creative work.

For the purpose of this column, we will recognize the term, communities of practice, as the generic umbrella that focuses attention on the learning how aspect of our professional knowledge base. We will use the term, networks of practice, to describe the application of information technology to connecting geographically diverse professionals in electronic communities that focus on issues of professional practice.

Networks of Practice in Special Education Technology

Not surprisingly, educational technologists quickly recognized the application of communication technologies for enhancing the function of sharing information to facilitate professional practice. Early initiatives such as specialized online bulletin boards like SpecialNet and AppleLink contributed to the development of geographically diverse online communities of practice.

Many of the current online communities in special education can trace their roots to the power and collaboration that evolved from SpecialNet in the 1980s and 1990s. While the tools have evolved, the basic principles associated with joining a community of practice and participating in its knowledge sharing activities remain the same.

The following section describes four notable special education technology networks of practice. The first two communities utilize e-mail based Listservs with a companion web page and the last two communities utilize Web-based discussion boards.

The QIAT Listserv

The QIAT Listserv was established in 1998 and is maintained by Joy Zabala. "Initially, the QIAT List was established to facilitate widespread discussion in the continuing development and refinement of the quality indicators by people with multiple perspectives in multiple locations who were interested in the development and delivery of quality assistive technology services in schools. Over the years, QIAT List discussions have evolved to focus not only on the quality indicators, but also on a range of topics that pertain to quality assistive technology services, such as decision-making, report writing, legal issues, research, staff qualifications, job openings, certification, device specifics, and state standards and a wide range of other topics" (J. Zabala, personal communication, 2005).

The QIAT Listserv is the oldest community of practice in assistive technology. This list is extremely active. Currently, over 1,000 individuals participate in this online community. Among the unique features of this community are the availability of a daily digest of messages and a searchable archive of over 10,000 messages that can be searched by title, author, topic, and keyword. The QIAT Listserv is hosted at the University of Kentucky and can be accessed via the QIAT web site: http://www.qiat.org.

The Assistive Technology Outcome Listserv

The Assistive Technology Outcome (ATOUTCOMES) Listserv was established in September 1998 and is maintained by Linda Petty. This electronic community was started as a means of providing participants in a workshop on client centered outcome measures with a forum for on-going education and networking (Linda Petty, personal communication, 2005).

The purpose of the Listserv and companion Web site is to support the development and use of reliable, valid, and sensitive outcome measures in assistive technology. These tools will enable assistive technology practitioners in determining the cost effectiveness of their services, valuing the provision of assistive technologies, and selecting the best technology from an array of choices. Subscribers are invited to share their expertise, experiences, resources, and questions relating to choosing, developing or implementing outcome measures in areas such as seating and mobility, computer access, vision technology and augmentative communication.

The ATO Listserv is hosted by the Adaptive Technology Resource Centre (ATRC) at the University of Toronto and can be accessed via the AT Outcomes Web site: http://www.utoronto.ca/atrc/reference/atoutcomes/

The Closing the Gap Forums

The Closing the Gap Forums were established in 2001 as a means of extending the rich conversations generated at the annual Closing the Gap conference. As a result, conference speakers and national leaders are invited to moderate discussion forums on specific topics of interest to the special education technology community.

While the content of forums may be viewed as a guest, the full value of the forum is experienced through free registration. One to two new forums are launched each month with many forums opening during the annual conference each October. Most forums operate for four weeks and are archived online when they are closed.

The forums attract a broad cross section of participants (parents, teachers, university folks, developers, technology specialists, etc.) (Jeff Steinborn, personal communication, 2005). As of May 2005, the forums have over 3,600 registered members. As a result, the Closing the Gap Forums are currently the largest electronic special education technology community of practice.

The Closing the Gap Forums can be accessed via the Closing the Gap homepage: http://www.closingthegap.com.

The Family Center on Technology and Disability Online Discussions

The Family Center on Technology and Disability is a federally-funded project designed to support organizations and programs that work with families of children and youth with disabilities. The Family Center is managed by a partnership of organizations, including the Alliance for Technology Access (ATA), Parent Advocacy Coalition for Educational Rights (PACER), Center for Assistive Technology and Environmental Access (CATEA) and InfoUse, Inc.

Since 2002, the Family Center has been hosting a monthly online forum featuring a national leader in special education technology. A wide variety of topics have been presented by a variety of individuals and teams of speakers. Each online discussion features an overview paper prepared by the presenter that includes selected resources about the topic. The online discussion is open for a month. Participants do not need to register to participate and can post questions anonymously or under a pseudonym. Presenters and other participants are able to comment on the questions. During the month, a rich web of information is generated by the participants. Discussions are archived following the discussion period.

The Family Center's online discussions are hosted by the Academy for Educational Development (AED) and can be accessed their online discussion web page: http://www.fctd.info/webboard/index.php

SUMMARY

Traditional professional preparation programs have placed a premium on knowledge that represents learning about a topic. Only recently has attention been focused on issues associated with the social context of learning and the importance of learning communities for facilitating the "know how" component of knowledge. This column has profiled four online networks of practice that support the daily work of special education technology professionals. Given the rich content of the practice knowledge base contained in various Listservs and forums in an accessible archived format, additional research on this underutilized component of our professional knowledge base is warranted.

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Book and Software Review

Associate Editor's Column

Barbara L. Ludlow, Ed.D., West Virginia University &
John D. Foshay, Ed.D., Central Connecticut State University

Technology Integration Texts: A Comparative Review

Guest Columnist: Prabha Hariharan. University of Wisconsin – Milwaukee

This review focuses on three recent books written to provide teachers with guidance in building their technology skills and using them to integrate technology into curriculum and instruction to meet the needs of all students. Each book offers useful information for classroom applications of technology and they are all well suited for use by a variety of readers. To prepare this review, the table of contents was scanned to understand the scope and sequence of each book and the books were read to study their organization and content. Each book is described and its unique aspects, strengths, and weaknesses are analyzed. Next, comparisons are made across the books to assess coverage of important topics and appropriate reader audiences. Finally, some suggestions are offered for selecting an appropriate book from among these three choices.

***Technology for Exceptional Children – Choosing Instructional Tools to Meet Students' Needs*, by Sarah Irvine Belson; Boston, NY: Houghton Mifflin Company, 2003; 326 pp. $57.96 paper.**

This book focuses on using technology to meet the academic goals of students with exceptional needs. It begins with four core principles for using technology in education. The second section discusses specific disabilities and describes the technologies that can be used for each. A special section is devoted to technology that can be used for the different academic content areas. The last part of the book provides information about the technologies that teachers can use for instruction, for developing the individual education plan (IEP), and for assessing and communicating student progress. The book also includes individual profiles as examples and information on a variety of resources. Guidelines are outlined for choosing technology based on both student needs and content areas.

This book provides a strong foundation for choosing appropriate technology for specific disabilities. It can serve as a valuable introduction for the assistive technology (AT) consideration and decision making processes of IEP teams. The author has touched upon technology for all students throughout the book, however, discussion of universal design in classrooms is limited to just one section. Appropriate reader audiences for this book are prospective and practicing teachers, administrators, and other professionals as well as parents of students with disabilities or other caregivers who will be involved in the AT selection and implementation process.

***Making Technology Work for Learners with Special Needs: Practical Skills for Teachers*, by Jean G. Ulman; Boston, NY: Pearson Education Inc., 2005; 223 pp. $35.20 paper.**

This book introduces readers to the process of using technology and developing a technology toolkit. The first section seeks to develop skills for using commonly available computer software. The second section discusses technology integration and the third section offers guidelines for using technology to make adaptations for learners with special needs by highlighting the use of specific technology software like Intellitools, Discover: Guide and IntelliPics Studio.

The book features practical guidelines with access to Web sites for practice documents and a list of keyboard shortcuts in the appendix for quick reference. Although specific software is discussed in detail, the author does not provide comprehensive information on the full range of software currently available. This book can serve as a useful resource for beginning teachers or perhaps parents with minimum computer experience. It can also serve as a text for courses that include computer labs on technology integration and assistive technology.

***Technology for Inclusion – Meeting the Special Needs of All Students* (4th ed.), by Mary Male; Boston, NY: Pearson Education Group, Inc., 2003; 185 pp. $36.80 paper.**

This book addresses technology integration as a means of empowerment for teachers. It begins by discussing technology as an empowering tool for teachers and the ways of developing one's own technology toolkit. Further, in this section, Male discusses universal design as a means of using technology to promote access to curriculum for all students and also for developing social skills. In the second section, the role of technologies in the content areas, with specific disabilities, and during transition in the life stages of children is examined. The third section takes a closer look at the Internet and virtual reality in enabling better learning and understanding of academic subjects. The last section looks at the laws and policies directing students' access to technology and the ways in which technology can be used to enable inclusion of students with special needs into schools and communities. This section ends with the author encouraging readers to have their own vision for technology as empowerment.

The strength of this book is that it covers a wide range of topics related to how technology can be used to promote inclusion. The book is a synthesis of the author's many interviews and discussions with parents, teachers, students and other personnel involved in education for students with special needs; therefore, it is rich in experiential accounts and suggestions for technology integration in the curriculum and classroom environment, including sample lesson plans. Teachers in general and special education, as well as other school and district personnel, will benefit from this book and it would make a useful book for any school library.

Comparison of Content

Technology integration for all students has been addressed in many ways in these three books. The Male book is comprehensive and incorporates both technologies for specific disabilities and developing one's own productivity toolkit. While the Ulman book provides a detailed discussion of helping teachers and other related professionals build their technology toolkit and skills for application in classroom; the Belson book focuses more on identifying suitable kinds of assistive and adaptive technologies for each category of disability and how other state of the art technologies can be used to promote learning. Both the Belson and Male books provide profiles and cases of students using technology for various academic activities. Ulman's book provides the most practical guidelines for technology toolkit development. Male discusses universal design for learning in great detail and Belson's book addresses it to some extent, but Ulman does not refer much at all to this issue.

Conclusion

Male's book, a classic in the field, can be used as a reference guide for technology integration and inclusion and as a foundation textbook for introductory courses. The book is comprehensive and has many examples, but certain areas such as productivity toolkit development and AT selection demand more detail and perhaps a supplementary text. The reader could use either Ulman's book or Belson's book for this purpose. Ulman's book can be used for building one's technology toolkit or for technology lab course instruction since it provides step-by-step instruction on various software programs. Belson's book can serve as a guide for AT consideration and selection since it outlines each disability and suitable technologies. All three books provide important resources in their appendices. Each book is written in a clear manner and all are easily readable. These books would be especially useful for teachers, therapists, and any professionals in training in the field of special education.

Sean Smith, Ph.D., University of Kansas

Teaching Family-Centered Practices On-Line and On-Campus

Guest Columnist: Diane Renne, Arizona State University

With the continued growth in alternative certification programs offered through institutions of higher education, school districts, and related organizations, online learning appears to be a viable option in a number of teacher preparation program concerns. With this tremendous growth and the increase in its use a varied teacher certification programs, we need to as a field better understand the effectiveness of online learning and how it can enhance the teacher preparation program. Likewise, we need to also better understand how it can hamper current quality and from these findings better develop hybrid courses to meet the demand while maintaining quality. This column offers a pilot study of a special education teacher preparation course that combined face-to-face with online supplemental instruction to further student understanding on issues related to family-centered practice.

Introduction

Family-centered practice is a core principle in the delivery of services to infants and young children with developmental delays and disabilities and their families. Beckman, Newcomb, Frank, Brown, Stepanek and Barnwell (1996) note four elements that characterize family-centered practice. These include (a) focus on the needs of the entire family, (b) respect for diversity, (c) flexibility in service delivery, and (d) an emphasis on parental choice and decision making. In the Birth to 5-year-old concentration for the M.Ed. in special education at a southwestern university, family-centered practices are interwoven into all courses in the curriculum, and are addressed in depth in the core course titled "Family-Centered Practice".

This graduate program, in place for six years, has some unique characteristics. Although the degree is a Master's in special education, enrollment in the program is open to and has attracted professionals from any discipline involved in providing services to infants and young children and their families. These have included early interventionists, preschool special education teachers, Head Start and Early Head Start teachers, nurses, and speech/language pathologists. The program delivery is structured to meet the needs of working professionals. Courses are taught in 8-week blocks, with 5-hour class meetings once a week. This enables people to complete two courses for six graduate credits each semester. Depending on their work commitments, individuals may also take elective courses during the semester. The program structure and curriculum were designed with community representatives including representatives of preschool special education, the state's early intervention system, and families (Garrett & Kelley, 2000).

In the Fall semester, 2003, Family-Centered Practice was taught as a hybrid course, using Blackboard as the instructional platform for the online portions of the course, and a combination of lecture and small- and large-group activities for the face-to-face portion. There were several reasons for this. Primary among them was an interest in eventually being able to offer coursework in the program on the web or through other distance learning strategies. In Arizona, as in many states, there is a shortage of personnel needed to deliver early services to children and families with special needs. If the program could reach beyond the metropolitan area where the university campus is located, the faculty could have a greater impact on meeting the personnel needs of the state. Initial exploration of the development of an online analog of the course took place during the 2002-03 academic year (Renne & Baldridge, 2003).

However, there were some concerns about the appropriateness of Web-based instruction for a course that is intended to prepare professionals to partner with families, and to engage in supportive and sensitive personal interaction. Ludlow (2001) has recommended that the profession proceed with caution and carefully evaluate the impact of technology on the preparation of special education personnel. A review of the literature found little that directly addressed the relationship between type of content and the effectiveness of web-based instruction. Welch & Brownell (2002) reported that they were able to positively influence knowledge about and attitudes toward collaboration with other educators through a technology-enhanced course for preservice special educators. However, they did not incorporate Web-based instruction in this exploration of technology.

A second purpose was to explore whether student participation and satisfaction would be enhanced if face-to-face meeting times were reduced and some of the course activities were conducted via the Web. Previously, participants had appreciated the benefits of the block scheduling of the course, however; the intensity of the class sessions were reported to be very draining, especially for those whose round-trip commutes were 50 to 100 miles. Thus, we sought to understand whether presenting some of the course activities on-line could enhance student contributions and student satisfaction while maintaining the learning of critical knowledge and skills. If yes, this would be an asset to the program and the students who participate in it.

Course Content and Assignments

This course is designed to give students knowledge of family systems theory and the implications of family systems for supporting and empowering families of young children with special developmental needs. Students are expected to demonstrate this knowledge and their application of the knowledge in a variety of assignments and course activities. Written assignments include designing a personal philosophy for working with families, and applying a family systems perspective to a first-person book written by a parent or other family member. Students are also expected to design and complete a final project related to family-centered practices that incorporates either field-based research or practical application of good practices.

There are two additional assignments. Each student is expected to bring to the class a description of a salient situation in their practice that involves a challenge in collaboration with a family. The student then leads and facilitates group discussion to analyze the situation and generate recommendations for improving collaboration. Finally there is a practical "examination" that requires analysis by small groups of a family vignette. Each vignette includes the description of a situation that presents a challenge in communication and/or collaboration between a family and professionals. The student teams must identify the factors creating the challenge and generate recommendations for resolving the problem.

Face-to-face Classes

During the face-to-face class sessions, a variety of activities are scheduled, including traditional lecture and large and small group discussions. Role-playing is another tool used in the face-to-face sessions. Role play requires the individual to take another person's point of view and to practice effective communication skills.

Video presentations are used as a springboard for large and small group discussions. Each of the videos used runs 30 to 45 minutes and presents real families. Some of the videos are commercial, others are produced by agencies in the state for educational purposes.

Online

The online portions of the course include readings and case studies to be addressed in asynchronous discussions. Readings are selected to provide context or to describe specific skills that might be applied to a particular case. The discussions are guided by specific questions or statements. Students must post their insights and comments, and respond to the postings of at least two other students. Time frames are specified for each of the discussions, usually no later than the day of the next face-to-face meeting. Typically, students met face-to-face for 2 to 3 hours each week, then completed that week's discussion topic online during the next week. We should note that during an initial trial of the online component, no synchronous discussions were scheduled.

Student Feedback for the Initial Trial

There were 23 students originally enrolled in the course. One, a high school special education teacher, withdrew after the first class. He indicated that he had misunderstood the course description. A second person withdrew after the third class, citing personal issues. The 21 students who completed the course were all women from a variety of professional backgrounds. They included home-based early intervention providers, preschool special education teachers, Head Start home- and center-based teachers, and a speech pathologist.

Following the final face-to-face class session, students were asked to respond online to nine questions evaluating their experience with the online component of the course. Twelve of the 21 students who completed the course answered the questions. The low return was disappointing. However, those who did respond provided some insight and direction for future course development.

Three of the 12 reported previous experience with hybrid courses and six stated they had previously completed one or more online courses. Nine of the 12 students indicated they would be interested in additional hybrid courses and provided several reasons. Convenience was a factor, of course. Most mentioned the benefit of participating at times that fit into work and family schedules. In addition, most of them provided comments related to quality, such as "my responses were more in depth" and "individually responding to situations was effective online."

Of the three who were not interested in further hybrid course, two cited lack of experience and/or comfort with technology as a reason. The third noted that it was too difficult to keep up with the work in both face-to-face and online classes.

Specific to the content of this course, only one of the respondents felt that it could effectively be offered as a wholly online course. Two people felt strongly that it should be solely a face-to-face course. The consensus of the other 10 respondents was that the hybrid format was effective. They cited advantages of the online components such as time to think, time to reflect, and having a written record of other people's thoughts and ideas. However, they also agreed that the online component needed to be balanced with face-to-face meetings. Several mentioned the importance of practice in reading other people's body language, facial expressions and vocal intonation in preparation for communicating with families. One comment noted that there was benefit to having the opportunity to practice both face-to-face and electronic communication skills. Some specific student comments:

"I would prefer a hybrid course over a completely on line course in order to have face-to-face interaction with the instructor."

"I liked being able to read other perspectives to the situation we were responding to and being able to respond to a peer about their point of view."

"I was able to write a little, walk around and think about it, write a little more."

"I think it would be exciting to have this program online with long weekend seminars…I also think that meeting in the class environment is rich and hope that ASU can do both or a combination of both."

Instructor Perspective

In terms of knowledge and application of content, one measure is the quality of work submitted by students. Of the 21 who completed the course, 12 achieved 95% or more of the total possible points. Five others achieved between 91% and 94%. This distribution of grades is consistent with the distribution in previous semesters when the course was taught solely face-to-face.

It is noted often that online instruction requires significantly more time on the part of the instructor. One of the things that compensates for this is increased opportunity to hear every student's voice. In face –to-face classes of 20 or more students, discussion is often dominated by a few students. Some may participate only if directly solicited by the instructor. They may be uncomfortable speaking in front of a group, need time to formulate their thoughts, or be distracted by situations at work or at home. In a night class following a full day of work, they may simply be too tired to organize and express their ideas. Breaking up the class into small discussion groups increases the likelihood that all will participate, but that alone does not enable the instructor to attend to everyone's contributions. This also limits students to hearing the ideas only of those individuals in their own groups.

Beckman and colleagues (1996) describe strategies for teaching competencies needed to work effectively with families. The include case studies, role playing and practicing specific interviewing skills. The experience with teaching this family-centered-practices class suggests that online discussions can provide an effective forum for responding to case studies. Student comments and the instructor's evaluation of participants' contributions to the discussion topics suggest that responses may be more thoughtful and in-depth than those generated in face-to-face discussion. There is also the benefit of having everyone participate, although some students expressed dissatisfaction with specific responses to their postings. In future iterations of the hybrid course, synchronous online discussion, with small groups using chat rooms, will be added to assess whether there might be an increase in interactions while still providing students the benefit of access to discussion in all groups through the archive system.

Role-play, on the other hand, demands that at least some subset of a class meet face-to-face. Practice in using interview skills, for example, clearly requires that at least two individuals meet face-to-face. Experience suggests that practicing specific skills such as open-ended questioning and paraphrasing with other students increases the quality of student interviews with families of young children. These two components seem incompatible with web-based instruction, thus solidifying the need for both face-to-face and online course activities.

Conclusions

This is an initial exploration of the value of Web-based instruction in teaching family-centered practices. The results must be very cautiously viewed. However, this experience suggests that a hybrid course combining web-based activities with face-to-face meetings can be effective in terms of students' satisfaction and their understanding of the principles of family-centered practice. On the other hand, students and instructor agreed that the nature of the content and the skills students need to be family-centered in their practice argue against a fully online course. To meet the challenge of providing the course to greater numbers of students statewide, other distance learning strategies have to be considered. The suggestion of the student quoted above, to combine online activities with intensive weekend seminars, may be an approach to accomplishing this in an effective manner. Clearly, there is a need for more analysis which we hope to accomplish in the near future.

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higgins@nevada.edu rboone@nevada.edu