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ABSTRACT

This final report describes activities and accomplishments of a 3-year federally funded project, Project LITT (Literacy Instruction Through Technology), which focused on developing the reading skills of elementary and middle school students with learning disabilities (LD) by using hypermedia-based children's literature. The project involved five interrelated studies focused on: (1) characteristics of hypermedia-based children's literature in relation to students' learning needs; (2) learning strategies used by students with LD in interactions with this type of software; (3) types of instructional supports needed to maximize reading gains that students receive from hypermedia-based children's literature; (4) the effectiveness of this software in improving students' reading skills; and (5) effectiveness of bilingual versions of the software with LD students who are English language learners. Findings indicated that when LD students engaged in unstructured interactions with talking storybook software their reading performance was not enhanced but when structured support was provided their time on task increased, as did gains in reading skills. Specific recommendations are offered for selecting talking storybook programs and for classroom reading instruction. (Contains 18 references, and information about LITT related conference papers, publications, and Web sites.) (DB)

FINAL REPORT

Project LITT (Literacy Instruction Through Technology):

Enhancing the Reading Skills of Students with Learning Disabilities

through Hypermedia-Based Children's Literature

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the U. S. Department of Education,
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CONTENTS

INTRODUCTION

Project Overview

"Project LITT (Literacy Instruction Through Technology): Enhancing the Reading Skills of Students with Learning Disabilities through Hypermedia-Based Children's Literature" was funded under the Research Projects That Promote Literacy competition of the Technology, Educational Media, and Materials for Individuals with Disabilities Program, Office of Special Education Programs.

The purpose of this three-year project was to study the effectiveness of a new type of reading software, hypermedia-based children's literature, in improving the literacy skills of students with learning disabilities. This new generation of software provides opportunities for students to interact with engaging narratives with rich, colorful illustrations; music, sound effects, and realistic digitized speech; and features such as speech- and hypermedia-enhanced text that support the reading process for poor readers. The major research question of interest was whether this type of software is a useful instructional tool for improving the reading skills of students with learning disabilities. The five interrelated studies in the project focused on characteristics of hypermedia-based children's literature in relation to students' learning needs (Study 1), learning strategies employed by students with learning disabilities in interactions with this type of software (Study 2), types of instructional supports needed to maximize reading gains students receive from hypermedia-based children's literature (Study 3), the effectiveness of this software in improving reading skills of students with learning disabilities (Study 4), and the effectiveness of bilingual versions of this software in improving the reading skills of students with learning disabilities who are English language learners (Study 5). Study 1 was conducted in the first year of the project (1996-97), Studies 2 and 3 in the second year (1997-98), and Studies 4 and 5 in the third year (1998-99).

Organization of the Final Report

All of the goals and objectives of Project LITT were accomplished, and the purpose of this Final Report is to present the findings of the five studies conducted during the project period. The report is divided into several sections. Included within this introductory section is an overview of the rationale

underlying the project. The next four sections describe the four phases of the project and the studies conducted as part of each phase. The next major section presents overall conclusions from the research and recommendations for practitioners. Last is a description of the strategies used to disseminate project activities and results.

Rationale for the Project

Reading is one of the most important of all literacy skills, and it is without doubt the academic skill most often linked to the school difficulties experienced by students with learning disabilities. These students, as a group, are characterized by the problems they encounter in acquiring beginning word recognition skills and comprehension strategies, in extending their reading abilities to levels consistent with those of their peers without disabilities, and in applying reading skills to the myriad reading tasks they face in the school years and thereafter in adulthood (e.g., Campbell & Howard, 1993; Hughes & Smith, 1990; Kos, 1991; Merrell, 1990; Santos, 1989; Werner, 1993; Zigmond & Thornton, 1985).

Given the promise of technology for students with learning disabilities and the frequency and severity of reading problems among this population, it would be logical to expect to find that a large portion of the special education technology research literature focused on computer-mediated instruction in reading. That is not the case. This lack of attention is due, in large part, to the interaction between the nature of beginning reading and hardware/software limitations. Until quite recently, few software programs appropriate for beginning readers were available (Lewis, 1998). Students with poor reading skills are unable to decode the text on the computer screen, and attempts to overcome the print barrier with synthesized speech were not particularly successful. The speech produced by early synthesizers was robotic, rather than natural sounding, and its intelligibility was inadequate for some students with disabilities (Helsel-Dewert & Van Der Meiracker, 1987; Massey, 1988; Smith, Siders, & Oshrin, 1987).

In the past few years, however, advances in software development and media storage capabilities have dramatically changed the nature of software for reading (Lewis, 1998). Software has moved from linear, sequential design to hypertext and hypermedia sequences where users can control the manner in which they interact with the program's content. At the same time, CD-ROM

technology has greatly increased the potential for adding natural sounding digitized speech to software for beginning readers. These technical changes have been accompanied by changes in thinking about beginning reading instruction brought about in large part by the whole language movement (Goodman, 1986; King & Goodman, 1990). In this approach, reading is contextualized, meaning is emphasized over isolated skills, and children read whole texts, not fragments. All of these developments acting in concert have led to a new generation of reading software, the talking storybook or, in more technical terms, hypermedia-based children's literature.

Hypermedia-based children's literature is one of the most popular types of software today (Diegmueller, 1995; Jackson, 1994), and students with learning disabilities are likely to have opportunities to interact with it as members of general education classes or as part of their special education instructional program. However, it is unclear how this type of software interacts with the limitations imposed by learning disabilities. Little research has been conducted in special education with this new instructional tool. Therefore, the purpose of this project was to investigate the effectiveness of hypermedia-based children's literature software in enhancing the reading abilities of students with learning disabilities.

Text Interactivity Rating	HIGH; 12 interactive text screens
Interactions with Graphics	In the Let Me Play mode, learners click on "hot spots" within the graphics. Actions result including animation of the graphics, sound effects, speech, and music. Learners can also access 5 activities from story pages.
Graphics Interactivity Rating	HIGH; 12 interactive graphics screens; 23 "hot spots" per screen, on average
Amount of Animation in Program	HIGH
Navigation through the Program	The program begins with a main menu where learners choose the interaction mode. On each story page are arrows to move to the previous or next page. Clicking on the page number brings the learner back to the main menu. The "Pages" choice at the main menu allows learners to go to any page within the story. The "Activities" choice allows learners to go directly to any of the five activities. Learners can also choose "Quit" to exit the program.
Features	• Print Option -- It is possible to print story pages. Press the ALT or Command key to display the menu bar; choose Print from the File menu. • Toy Copter -- Use the remote control to fly the helicopter to the target and drop, then rescue the firefighter. • Deep Dark Sea -- In this computer game, help the diver find the treasure; hazards include running out of oxygen and sea creatures such as sharks and octopuses (3 levels of difficulty). • Frankenfish -- Learn about fish by clicking on their names. Make silly fish by rearranging heads, bodies, and tails; stickers can also be added. Fish pages can be printed. • Treasure Hunt Game -- One or two can play this board game. Players choose to be Arthur or Buster, then select one of three levels; the object is to reach the treasure first. In all levels, players match words and pictures, although difficulty increases. The winner gets to decide how to spend the treasure. • D. W.'s Store -- Visit the store to buy accessories for toys; when learners run out of money, they can earn more at the café by following recipe directions.
Definitions and/or Glossary	no
Writing Activities	no
Reading Activities	yes
Description of the Series	The Living Books series is a large (>10) collection of programs designed for learners in the elementary grades. Books are primarily by contemporary authors such as Marc Brown, Mercer Mayer, and Stan and Jan Berenstain. Most programs include a print book along with a CD-ROM (although the on-screen story is usually shorter than the book version). Each CD-ROM contains one story. All programs are in English and several offer versions of the story in other languages, with Spanish being the most common. (Search for other titles in the series.)

Results and Conclusions: The Software Search

The first major conclusion that can be drawn from the software search is that there is a large number of talking storybook programs currently available. In planning the project, we had estimated that 50 to 75 such programs existed; our

For example, the Living Books CD-ROM Stellaluna contains 343 words whereas the print book contains 1,201.

Estimated readability level. The readability level of the on-screen text may be different from the print book, and it may also be inconsistent with the age or grade levels recommended by the publisher. We used the Grammatik program to compute estimated Flesch-Kincaid readability levels for all stories in the Project LITT collection. Estimated reading levels ranged from grade 1 through grade 8. On-screen stories were fairly equally distributed between the grade 1-2 range (28%), the grade 3-4 range (39%), and the grade 5-6 range (27%).

Age-appropriateness. The age-appropriateness of programs is related not only to readability but also to factors such as story content and the program's appearance. Stories that are likely to interest and appeal to younger elementary grade students may be written at higher grade levels. For example, Winnie the Pooh and the Honey Tree, one of the programs in Disney's Animated Storybook series, is recommended by the publisher for ages 3 to 8; its estimated readability level is grade 7. Also, some programs incorporate music, cartoon characters, and children's voices that make them most appropriate for young students, even though the story content and reading levels may make more sense for older students.

Availability of languages other than English. Some talking storybooks are bilingual or multilingual (23%). When languages other than English are available, Spanish is the most common although some books provide French, German, and Japanese versions. In some multilingual programs, the story appears in its entirety in each language addressed. For example, there may be a version of the story in English and a separate version in Spanish. However, some programs provide only limited support in a language other than English. For example, students may be able to click on a word in the English text to hear (but not see) its Spanish translation.

Text interactivity. The programs in the Project LITT collection allow students to interact with the text and hear that text read aloud (programs without that feature were excluded). In all programs, students can hear the entire on-screen "page" read aloud. In more than half of the programs (56%), students can also hear individual words read aloud, and these programs were rated "high" in text interactivity.

Interactivity with graphics. Much more variability among programs was seen in the amount of graphics interactivity. The range extended from programs with no opportunities for interactions with graphics to those with literally dozens of opportunities ("hot spots") on each "page." Thirty-eight percent of the talking storybooks offered no opportunities for interactions with graphics, and these tended to be programs designed for school markets (e.g., WiggleWorks, Multimedia Literature). In 17% of programs, there were more than 15 "hot spots" per page, on average; these programs were rated "high" in graphics interactivity. In most cases, students clicked on hot spots to see animations of the graphics and hear speech, music, and/or sound effects. In some program series (e.g., Discis Books, Top Hat Tales), clicking on a hot spot produces a picture label. For example, if the student clicks on the picture of a duck within the story illustration, a label with the word "duck" appears and the word is pronounced.

Features and activities. Many talking storybook programs offer features and activities that support the development of literacy skills. The most typical literacy activity is a word processing feature, provided by 55% of the programs. Reading mini-lessons or activities were found in 38% of programs and word definitions and/or glossaries in 38%. Programs designed for the home market were more likely to contain games and activities such as matching, concentration, mazes, and the like. For example, Hunchback of Notre Dame, one of the titles in Disney's Animated Storybook series, contains five activities including arcade-type games such as "Gargoyles vs. Soldiers" and "Climbing Down the Walls."

Stage 2: Viewpoints of Students and Teachers

The second phase of Study 1 began in mid-March 1997 with the issuing of invitations to all special educators serving students with learning disabilities in the North Coastal Consortium for Special Education, a consortium of 13 school districts in San Diego County. Invitations were sent to 194 teachers, and 83 teachers volunteered to participate. Three focus group meetings were scheduled, teachers were placed into groups depending upon their availability to attend meetings on specified dates, and 52 teachers were randomly selected to attend. Focus group meetings were held on May 21, May 22, and June 4, 1997 with a total of 41 teachers attending.

The format of each meeting included small group discussions (groups of 3 to 5 teachers meeting with one project staff member) and a large group discussion at the end. During the small group discussions, staff members demonstrated representative hypermedia-based children's literature programs, then asked a series of questions related to the appropriateness of each program for use in reading instruction with students with learning disabilities. In the large group discussion, teachers were asked for their overall impressions of the software and their recommendations for its use. Results were analyzed across focus groups to determine trends in teachers' perceptions of the software.

Focus groups were also held with students with learning disabilities. Teachers attending the teacher focus groups were asked whether they would allow students in their programs to participate; all teachers (n = 41) agreed. To insure a student sample representative of several grade levels, 6 teachers were selected: two serving students in the primary grades, two serving students in the intermediate grades, and two serving middle school students. A total of 12 students participated. Staff members met with students individually or in small groups. Representative software programs were demonstrated and students asked their opinions about features of the software, age appropriateness, and usefulness for learning reading skills. Results were analyzed across focus groups to determine trends in students' perceptions of the software.

Results and Conclusions: Teacher and Student Viewpoints

Students with learning disabilities and their teachers were asked to view representative talking storybook programs and share their views on the usefulness of these programs for improving reading skills. Results were quite similar for students and teachers. Both groups were enthusiastic about the potential of hypermedia-based children's literature software for students with learning disabilities. However, teachers were less likely than students to rate graphics interactivity as an important advantage of this software. Instead teachers preferred programs with reading-related features such as word processing activities. In general, teachers recommended this software for students with learning disabilities in the elementary grades, although this recommendation was qualified with the caveat to consider each student individually. Students appeared to be less conservative in their views of the

age-appropriateness of the software, indicating that some middle school students might benefit from its use.

The students with learning disabilities who participated in the focus groups were in grades 2 through 7. Students were very enthusiastic about the talking storybook programs they viewed. All liked the programs and, when asked what they liked best, students identified features related to the interactivity of the software. For example, several students commented on the animated graphics that brought story illustrations to life. One sixth grade girl said, "It looked like it was really happening." A fourth grade boy observed, "It moves instead of a book that just stays." Students also talked about text interactivity. As one fourth grader said, "I can find a word and it says it." In most cases, students were not able to identify aspects of the programs that they did not like. However, two second graders who viewed a program with no graphics interactivity complained that the pictures didn't move. Students were asked whether they thought that talking storybook programs would help them to read better. Most students felt these programs would improve their reading skills because the story is read aloud, "it shows the words and you can read along with it," and "you can click on a word and it will say it."

Teachers had generally positive reactions to the talking storybook programs they viewed during the focus group discussions. However, they were critical of program features that they felt detracted from instructional goals, and they had strong opinions about which features software developers should include when designing programs to enhance students' reading skills. In addition to pointing out that clear directions are essential for student success, teachers' discussions centered around three main areas: the text presented in the stories, the graphics components of the software, and program features related to instruction and individualization.

Text considerations. Many of the programs evaluated by the teachers were based on print books and, in some cases, the books were included with the software package. Teachers felt this was a good practice because it gave students the opportunity to interact with both the traditional print and software versions of the story. Teachers preferred programs that did not deviate substantially from the text of the book. Unfortunately, many children's books are quite long and the text is condensed when the software version is created.

Teachers viewed programs very positively if they offered versions of the story in languages other than English. Spanish is the language other than

English that is most often available in talking storybook programs, and the teachers felt this choice was the best for the population of students they served. Programs offering only English text were considered much less desirable than multilingual programs.

Several factors related to the appearance of the text on the screen were considered important by teachers. They preferred text styles and fonts that were familiar to children and easy to read. They believed text should be large enough for it to be seen easily, and there should not be too much text on any one screen "page." The color of the text should be chosen so that the words stand out from the background, particularly when the background is a "busy" graphical illustration. Even more preferable is text on a plain white or neutral background. Several teachers commented on the placement of the text on the screen. In most cases, teachers wanted the text placed in a logical location (e.g., at the bottom of the screen) and preferred that text remain in the same location from screen to screen. Teachers particularly liked programs where the on-screen displays resembled books (e.g., the Reader Rabbit's Reading Development Library Series).

Teachers preferred programs where the text is highlighted as it is read aloud. In general, teachers wanted text highlighted either word by word (to direct learners' attention to individual text elements) or phrase by phrase (to encourage more fluent reading and better comprehension). Less desirable were programs that highlighted entire sentences or each line of text. Least liked were programs where text was not highlighted because teachers believed that students with learning disabilities would not be able to keep their place in the text. The method used to highlight text was also important. Teachers criticized programs where colored highlighting made text more difficult to see.

In all of the programs that teachers reviewed, the text on the screen was read aloud. Teachers considered this feature essential for instruction but voiced some concerns. Although teachers wanted the programs to move along at a brisk pace to keep students' interest, one common complaint was that the narrator read too quickly. Teachers feared that students would have difficulty keeping up and would become lost. Teachers preferred narrators who read with expression and criticized those with monotone or "boring" voices. Also, teachers felt that juvenile or "babyish" voices would be unattractive to older students.

Most programs viewed by the teachers allowed students to hear the text read aloud again (after the page had been read in its entirety). Teachers liked

this capability, particularly when students were able to select individual words rather than sentences, paragraphs, or the entire selection on the page. Also highly rated were programs that provided information about word meanings. Included in the software sample were examples of programs that offered definitions and explanation of words in a variety of modes including text, text accompanied by speech, multimedia presentations with brief video clips, drawings or illustrations (for nouns), and animated graphics sequences (for verbs).

Teachers were very sensitive to the content of the story, its value as literature, its appeal to students, and its fit with the goals of the curriculum. Several programs were praised for their inclusion of diverse groups and their multicultural themes. Teachers also carefully examined the structure of the language used in the stories, and those working with less able readers favored predictable and repetitive texts and ones that included rhyming words and high frequency vocabulary.

One major concern was the appropriateness of the programs given the discrepancy between their students' ages and the grade levels at which they were able to read. Teachers criticized stories they perceived as too juvenile in content. They were also concerned that the reading level of some stories might be too high. The stories in the programs reviewed by teachers ranged in readability level from grade 1 to grade 6. However, even some of the stories with the lowest readability levels were considered too difficult for some elementary grade students.

Considerations related to graphics. Teachers evaluated the illustrations accompanying the stories in terms of their appeal to students, age appropriateness, and general quality. Teachers expressed individual preferences for some illustrations; for example, some professionals liked more realistic depictions of the characters in the story rather than cartoon-style drawings. Teachers were particularly concerned that illustrations not be too "primary" and that the age level to which they appealed be congruent with the content of the story and the readability of the text.

The programs that teachers viewed ranged from those with no capacity for interaction with the graphics on the screen to others with very large numbers of interaction opportunities. One way to quantify this is by the numbers of "hot spots" per screen. A hot spot is a screen location which, when selected by a student, produces some type of result. Examples are: (a) the appearance of a

picture label (e.g., the word "dog" appears next to a graphic of a dog and the word is read aloud), (b) a short animation sequence involving one of the objects on the screen and sound effects (e.g., a flower sways to music or a dresser drawer opens and bangs shut), and (c) a more prolonged animation sequence in which characters in the story move, speak, and interact accompanied by sound effects and/or music. The programs used in the demonstrations varied from some with no hot spots to those with more than 40 hot spots per screen, on average.

On one hand, teachers were enthusiastic about programs with interactive graphics because they felt they'd be highly motivating to students. Comments included "It makes learning fun," "Grabs kids," and "high interest level." On the other hand, teachers were highly critical of programs that contained "too many" hot spots and those where selecting the hot spots disrupted the continuity of the story. Teachers seemed to prefer programs in which the graphical interaction related to the story (e.g., The Living Books Series), the interactions retold the story (Reader Rabbit's Reading Development Library), or the interactions were simple picture labels rather than animation sequences (e.g., Top Hat Tales, Discis Books). Teachers also liked the WiggleWorks series which offers no graphics interactions. As one teacher remarked, "I like that this focuses on actually teaching reading."

Another concern raised by teachers related to long action sequences that preceded and/or followed the oral reading of the text on the screen. Most felt that, although these sequences related to the story, they distracted students from the reading task.

Other considerations. Three other areas were repetitive themes in teachers' discussions of the programs: games and other activities, instructional features of the programs, and options for individualization.

In general, teachers were not impressed with games and other types of activities embedded within the stories. They felt they disrupted the continuity of the story line and, although entertaining, were too much of a distraction. Most criticized was the Disney's Animated Storybooks series designed for use at home, not school. Teachers' observations included "Too 'gimmicky,'" "more for entertainment than education," and "students would go to game before choosing to read text on their own."

The instruction-related features of the programs typically were adjunct activities which students (or their teachers) could choose to select. Overall,

teachers were pleased with these features and felt they contributed to the educational value of the programs. Most common were writing activities such as "blank books" where students could write and illustrate a story. Also available were more structured writing tasks such as the letter writing activity in Reader Rabbit's Reading Development Library (students choose sentence endings) or the "Let Me Write" activity in Arthur's Reading Race from the Living Books series (students modify sentences by selecting objects on the screen).

Teachers also liked programs that provided or collected lists of words to which students could refer. For example, the Discis Books keep a record of each word the student selects. The WiggleWorks programs allow students to build a "My Words" list as they read a story, and those words can then be used in the programs' writing activities.

Other popular features were the ability for students to tape-record their voices as they read stories aloud (e.g., the WiggleWorks series) and activities or options that promote comprehension skills. For example, the Reader Rabbit's Reading Development Library series offers two comprehension features. At the start of each story, the student selects the narrator (e.g., in "The Three Little Pigs," a traditional storyteller, the second pig, or the wolf), and the story then is told from the point of view of that narrator. Also available is a Story Map activity where students put pictures of the events in the story in order.

Art activities were available as part of the writing activities in several programs, but teachers did not regard these as important features. However, teachers were enthusiastic about The Art Lesson, one of two programs in MECC's Stories That Click series. This is an autobiographical story read aloud by Tomie de Paola, the author and illustrator. It includes 14 art activities embedded with the story, and teachers felt these would motivate students, particularly those with interest and talent in art. Teachers also liked the two extension activities in the program, an interview with the author/artist and a tour of his studio, both of which include brief video tape segments.

Teachers liked programs that gave them some control over instructional parameters and enabled them to customize program features to the needs of individual students. Examples of customization options available in some programs are the ability to change the size, style, and color of text; to turn the highlighting on or off; to modify the speed with which text is read aloud; and to determine what portion of the text is read aloud automatically (e.g., the entire selection or individual sentences). Unfortunately, only a few software series

offer features such as these, and no program allowed teachers to control the elements they found most intrusive to the learning process: games embedded within the story and the number of hot spots per page. Teachers also expressed a desire for record keeping capabilities within programs to help in monitoring student progress; again, no program offered this feature.

Study 2: Characteristics of the Interactions of Students with Learning Disabilities with Hypermedia-Based Children's Literature

The purpose of Study 2 was investigation of the learning strategies employed by students with learning disabilities in nonstructured interactions with hypermedia-based children's literature programs. This observational study was conducted in Spring 1998.

Based upon the results of Study 1, several research questions were posed for investigation in Study 2. These centered around three major characteristics of this body of software: opportunities for interaction with text, opportunities for interaction with graphics, and opportunities for interactions with program features (e.g., definitions and glossaries, games, word processing activities, mini-lessons on reading). The research questions are:

- *Text.* Do students with learning disabilities listen and attend to text in hypermedia-based children's literature software? If individual words in the text are interactive, do students choose to interact with them? If definitions for words in the text are available, do students choose to access those definitions?
- *Graphics.* Do students with learning disabilities attend to the graphical components of this body of software? Do students interact with graphics hot spots that produce picture labels as frequently as they interact with hot spots producing animation, sound effects, and speech? Do students spend a greater proportion of time interacting with graphics components than with program text?
- *Features.* Do students with learning disabilities choose to interact with program features? Do students spend a greater proportion of time interacting with features resembling games than with features related to the development of reading/language arts skills?

Methodology

Participants. Students were selected for this study in a two-part process. First, all teachers selected for Study 1 focus groups (n = 52) were invited to participate in this study. Fifty teachers indicated their willingness to participate and four were selected. These teachers provided detailed information on the characteristics of each of the students they served and project staff, in collaboration with teachers, selected six students for inclusion in the study. Two teachers each served two of the students; two teachers served one student each.

The six students included five boys and one girl; all received special education resource services because of a school-identified learning disability. All students performed within the average range on tests of intellectual performance and within the low average or below average range on measures of reading performance. Two students were in grade 3, three in grade 4, and one in grade 5. All had IEP goals in the area of reading. Their special education teachers estimated that these students were reading 1 to 2 years below grade level, confirming reading as an area of need.

Materials. To answer the research questions posed in this study, it was necessary to select software programs representing the range of characteristics under investigation. The first step was identification of three types of program. Type 1 included programs with high text interactivity and varying degrees of graphics interactivity; definitions and program features are not available and hot spots produce animation sequences rather than word labels. Type 2 included software with the same characteristics except that program features are available and text interactivity ranges from high to medium. In Type 3, all programs provided definitions but varied in text interactivity (high versus medium) and in graphics interactivity; programs with picture label hot spots were represented as well as those with graphics hot spots.

The next step was categorization of the programs in the software collection on the basis of these software types. Then, six programs of each type were selected. Table 1 describes each software type and lists the programs chosen to represent each.

Table 1

Software Types and Representative Programs

Type	Characteristics	Sample Programs (Series)
1	high text interactivity, no embedded games or activities, and varying interactivity with graphics	• Imo and the King (Magic Tales) • Tortoise and the Hare (Living Books) • Goose that Laid the Golden Egg, King Midas (Reader Rabbit) • Best Wishes, Ed; Jimmy Lee Did It (Story Web)
2	varying text and graphics interactivity and games and activities embedded within the story	• Sheila Rae, the Brave; Stellaluna (Living Books) • Art Lesson (Stories that Click) • Lion King, Hercules (Disney)
3	varying text and graphics interactivity, definitions or glossary features, and picture label and graphics "hot spots"	• Humphrey, Tiger Came to Dinner (Top Hat Tales) • Hunchback of Notre Dame, 101 Dalmatians (Disney) • Jack and the Beanstalk, Peter Pan (EduTales)

Treatments. A project staff member worked individually with each student at a computer in the student's special education classroom. At the start of the first session, the staff member explained that the purpose of this activity was to find out how students used reading programs and how well students liked these programs. Students were also informed that the staff member would be watching them and taking notes and videotaping them as they worked with the computer. The staff member then demonstrated how to operate the program and how to access its features. For the rest of this and all subsequent sessions, students were encouraged to interact with the program in any way they chose. Staff members answered questions about program operation if they arose but did not direct the student to engage in any particular program activity.

Measures. Word recognition measures were designed for each software program to be used by students in the study. Each measure contained 50 words from the story; high frequency words and those central to the story's plot were included with the remaining words selected randomly. Students were

asked to read each of the 50 words aloud before they began working with a program and immediately after they finished working with the program. At that time, they were also asked to retell the story and to answer questions about their perceptions of the software.

An observation form was developed for project staff to use in recording students' interactions with the software program. The form (one for each program) listed the students' options on each "screen" of the program. For example, the words that appeared on the screen were listed and the staff member was directed to mark each word that the student selected to hear read aloud. Other options were program "hot spots," word definitions, embedded activities or games, and navigation choices such as leaving the program or returning to the main menu.

A second observation form was developed for analysis of the videotaped data. This form contained equivalent categories of student options for interacting with the program but the information recorded was duration data, rather than frequency. Duration was recorded in seconds. Three major categories of behaviors were identified: teacher behaviors, program events, and student behaviors. Teacher behaviors included such activities as introducing the program, managing behavior, or directing the student to perform some task (e.g., "It's time to stop for today. Please quit the program."). Program events were defined as those actions that the program performed automatically. For example, on some programs, when the student turns the page, the text on the screen is read aloud and the graphics animate. Student behaviors included:

- Student directs program to read a word or a page aloud
- Student himself or herself reads aloud
- Student activates "hot spot"
- Student engages in game or activity
- Student directs program to provide definition
- Student navigates from one part of the program to another
- Student is off task

Procedures. Treatments were randomly assigned to teachers and specific programs selected for students based upon individual reading levels. Each student interacted with three different programs of one type, each for a total of 2 hours over 4 days. The treatment sequence involved pretesting on program 1, implementation of the program 1 treatment for 4 days (120 minutes), and posttesting; this sequence was then repeated for programs 2 and 3.

Posttesting involved administration of the word recognition measure (the pretest), a story retell activity (to assess comprehension), and an interview to elicit students' views of the software. All pretest, posttest, and implementation activities were videotaped; in addition, project staff members administering the treatments took detailed written notes using observation forms specific to the programs under study.

Results and Conclusions

Six elementary grade students with learning disabilities were introduced to a range of hypermedia-based children's literature programs, then observed as they interacted with these programs under unstructured classroom conditions. Programs were carefully chosen to represent the heterogeneity of this body of software because we hypothesized that some types of programs contained greater numbers of "attractive nuisances" than other types. When students with learning disabilities interacted with programs with many opportunities for interactions with graphics and those with game-like activities, we believed students would be more likely to be distracted from the reading task and thus less likely to learn new words. This did not prove to be the case.

The first major finding of Study 2 was that the type of talking storybook program did not matter. Students' patterns of interaction with the software did not vary from one program type to another. With all types, students with learning disabilities chose nonreading activities over reading activities. Analyses of videotapes indicated that students spent at least 40% of each 2-hour instructional period engaged in nonreading activities such as interacting with hot spots in the graphics, playing games, and engaging in other types of activities. As Table 2 illustrates, nonreading time ranged from 42.8% to 79.5% of the time, with an average across all programs of 64.6%. In contrast, students rarely asked to hear a word or page read aloud. At no time did a student read a word or sentence aloud.

Given students' lack of attention to the textual aspects of the software, it is not surprising that gains in reading skills were minimal. At pretest, students read an average of 31 of the 50 words selected from each story. At posttest, students showed an average gain of only 2.4 words. Comprehension, as measured by story retells, was adequate with an overall average of 68.1% accuracy.

Table 2

Percentage of Time Spent on Various Program Activities

		Characteristics				% of Time Spent by Student			
Type	Program Name	Text	Graphics	Features	Definitions	Hot Spots	Activities	Definitions	TOTAL
1	Tortoise & the Hare	High	High	N/A	N/A	64.3%	N/A	N/A	64.3%
	Imo & the King	High	High	N/A	N/A	53.8%	N/A	N/A	53.8%
	King Midas	High	Medium	yes: reading, writing	N/A	50.8%	17.9%	N/A	68.7%
	Goose That Laid the Golden Egg	High	Medium	yes: reading, writing	N/A	39.1%	5.1%	N/A	44.3%
	Jimmie Lee Did It	High	N/A	yes: reading	N/A	N/A	78.4%	N/A	78.4%
	Best Wishes, Ed	High	N/A	yes: reading	N/A	N/A	59.0%	N/A	59.0%
2	Sheila Rae, the Brave	High	High	yes: map game, sing-along	N/A	28.0%	14.8%	N/A	42.8%
	Stellaluna	High	High	yes: bat quiz	N/A	53.6%	0.0%	N/A	53.6%
	Art Lesson (student 1)	High	Medium	yes: art, interview, tour	N/A	24.2%	55.4%	N/A	79.5%
	Art Lesson (student 2)	High	Medium	yes: art, interview, tour	N/A	31.4%	45.4%	N/A	76.9%
	Lion King	Medium	Medium	yes: games	yes	23.4%	26.4%	0.5%	50.3%
	Hercules	Medium	Medium	yes: games, sing-alongs	yes	27.5%	35.7%	0.8%	64.0%
3	Humphrey	High	Medium (picture labels)	yes: writing	yes	17.4%	38.2%	15.6%	71.1%
	Tiger Came to Dinner	High	Medium (picture labels)	yes: writing	yes	28.2%	39.1%	10.0%	77.3%
	Jack & the Beanstalk	Medium	N/A	yes: activities, glossary	N/A	N/A	70.3%	N/A	70.3%
	Peter Pan	Medium	N/A	yes: activities, glossary	N/A	N/A	63.2%	N/A	63.2%
	Hunchback of Notre Dame	Medium	Medium	yes: games, sing-along	yes	9.9%	62.5%	0.0%	72.3%
	101 Dalmatians	Medium	High	yes: games, sing-alongs, activities	yes	18.7%	53.6%	0.0%	72.3%

22

These results suggest that students with learning disabilities are not likely to benefit from unstructured interactions with talking storybook programs. These students choose to interact with the graphics components of software rather than with the text, and they fail to take advantage of supports within the program such as speech aids and word definitions. This pattern of interaction has important implications for the use of hypermedia-based children's literature software in instructional programs designed to enhance the reading skills of students with learning disabilities.

PHASE TWO

Study 3: Instructional Supports to Facilitate the Use of Hypermedia-Based Children's Literature

The purpose of Study 3 was investigation of the types of instructional supports needed to maximize reading gains students receive from hypermedia-based children's literature. This study was conducted in Spring 1998. Results of Study 2 were used to design two types of instructional supports for students with learning disabilities, moderate supports and high supports. The purpose of these supports was to focus students' attention on the reading tasks in order to increase opportunities for the acquisition of reading skills.

Methodology

Participants and Materials. The six students who participated in Study 2 also served as subjects for Study 3. Each student interacted with four different talking storybook programs. Programs were selected to include those with high text interactivity and those with medium text interactivity. With high text interactivity, the student can direct the program to read not only the whole page aloud but also each individual word. With medium text interactivity, the student can direct only the whole page to be read aloud. Examples of programs with high text interactivity are those in the Living Books series (e.g., Arthur's Birthday, Harry and the Haunted House) and the Top Hat Tales series (e.g., Rooster Tells a Tale, Beautiful Feast for a Big King Cat). Examples of programs with medium text interactivity are those in the Magic Tales series (e.g., Imo and the King) and the Disney Animated Storybook series (e.g., Lion King, 101 Dalmatians).

Treatments and Measures. In contrast to Study 2 where students' interactions with talking storybook programs were unstructured, in Study 3 we provided increasing levels of instructional support. One important aspect of the support conditions was to limit the amount of time students spent in nonreading activities. However, because these types of activities appear to be highly motivating to students, they were not totally eliminated. On each page of a storybook, students were allowed to access two hot spots in the graphics. Also, at the end of each 30-minute instructional session, students were given 5 minutes of free time when they could reread the story, interact with hot spots, or play games or other activities.

Students interacted with four talking storybook programs, the first two under moderate instructional support conditions and the second two under high

instructional support conditions. In the moderate support condition, students were asked to read each page of the story aloud. In the high support condition, students were required to read each page aloud until they reached a criterion of 90% accuracy. In both conditions, students read storybooks with both medium and high text interactivity. These variations in text interactivity allowed students to experience four different levels of instructional support:

- *Moderate support, whole page only:* Students read each page aloud once.
- *Moderate support, whole page and individual words:* Students read each page aloud once, after reading 3 individual words on the page.
- *High support, whole page only:* Students read each page aloud to criterion.
- *High support, whole page and individual words:* Students read each page and 3 individual words per page to criterion.

Pretest and posttest data were collected for each program using the same measures as those employed in Study 2.

Procedures. Study 3 used virtually the same procedures as Study 2. Specific programs were selected for students based upon individual reading levels. Each student interacted with four different programs, each for a total of 2 hours over 4 days. All students followed the schedule of treatments described above: (a) moderate support, whole page only; (b) moderate support, whole page and individual words; (c) high support, whole page only; and (d) high support, whole page and individual words. The treatment sequence involved pretesting on program 1, implementation of the program 1 treatment for 4 days (120 minutes), and posttesting; this sequence was then repeated for programs 2, 3, and 4. Posttesting involved administration of the word recognition measure (the pretest), a story retell activity (to assess comprehension), and an interview to elicit students' views of the software. All pretest, posttest, and implementation activities were videotaped; in addition, project staff members administering the treatments took detailed written notes using observation forms specific to the programs under study.

Results and Conclusions

As would be expected, the amount of time that students spent on nonreading activities decreased from 65% in Study 2 to 28% in Study 3. More important, however, was the growth students experienced in reading skills. As

the amount of instructional support increased, the number of new words learned per program increased (see Table 3). Clearly, there appears to be an increase in word recognition gains as students progressed through the four levels of supports. These results are even more interesting when it is recalled that students in unstructured interactions with the software gained an average of 2.4 words per program. Also of note is the modest increase in reading comprehension scores from 68.1% under unstructured conditions to 77.6% in Study 3.

Table 3

Word Recognition Gains at Different Levels of Instructional Support

Condition	Type of Support	Element(s) Read Aloud	Reading Gains
1	Moderate	page	4.8 words
2	Moderate	page, words	6.8 words
3	High	page	8.8 words
4	High	page, words	9.6 words

PHASE THREE

Phase Three of Project LITT involved a large-scale experimental study designed to determine the effectiveness of hypermedia-based children's literature software in improving the reading performance of students with learning disabilities. The study utilized a pretest-posttest control group design with a standard control group of students with learning disabilities who did not participate in a hypermedia-based children's literature treatment. Norm-referenced measures of reading were used to allow comparison of the performance of students with learning disabilities to that of general education peers without disabilities. Two experimental groups represented the two major types of text interactivity available in talking storybook software, medium text interactivity and high text interactivity. Instruction was delivered to the experimental groups using the set of high structure instructional procedures developed in Phase Two of the project. Several dependent variables were measured including decoding, word recognition, and reading comprehension skills. Also of interest were possible changes in the attitudes of students toward the reading process.

Five research questions were the focus of Phase Three of the project:

1. Does the use of hypermedia-based children's literature software improve the reading performance of students with learning disabilities?
2. Does hypermedia-based children's literature software have differential effects upon students' gains in decoding, word recognition, and comprehension skills?
3. How does the introduction of hypermedia-based children's literature into the curriculum affect students' attitudes toward reading?
4. Is the achievement gap between students with learning disabilities and their general education peers without disabilities narrowed with the use of hypermedia-based children's literature?
5. Which type of hypermedia-based children's literature programs are most beneficial for students with learning disabilities: those that offer high text interactivity or those that offer medium text interactivity?

Study 4: Effects of Hypermedia-Based Children's Literature on the Reading Performance of Students with Learning Disabilities

Study 4 was a large-scale, long-term investigation of the effectiveness of representative types of hypermedia-based children's literature programs on the reading performance of students with learning disabilities. Study 4 was conducted in school year 1998-99. In order to examine the effectiveness of this body of software in realistic classroom situations, teachers were trained to deliver the high structure instructional intervention developed in Study 3 to the students they served in special education classrooms.

Methodology

Participants. A modified random sampling approach was used to select students with learning disabilities for participation in this study. All teachers serving this population in a 13-district special education consortium were invited to participate. Forty-five teachers volunteered, and 20 teachers were selected. Of these, one was forced to withdraw from the study because general education teachers in her school refused to assist in the provision of computer-based interventions to students placed full-time in the regular class. The remaining 19 teachers nominated a total of 198 students meeting these identification criteria: (a) identified by the district as having a specific learning disability, (b) not identified by the district as limited in English proficiency (LEP), (c) enrolled in grades 1 through 6, and (d) having one or more IEP goals in the area of reading. Four to six students were randomly selected from each teacher's list of nominations, resulting in a total of 88 students. Treatments were then randomly assigned to teachers; treatment #1 (medium text interactivity as represented by the Disney's Animated Storybook series) was assigned to 10 teachers and treatment #2 (high text interactivity as represented by the Living Book series) to 9 teachers. Students in each classroom were then randomly assigned to either the experimental condition (approximately 2/3 of students) or control condition (1/3 of students). Some attrition took place during the year-long study, resulting in a final sample of 83 students: 29 in experimental group #1, 27 in experimental group #2, and 27 in the control group.

Sixty-five percent of the students with learning disabilities were male; 95% received services in resource programs and the rest in special class settings. The sample was primarily white (58%), Hispanic (30%), and African

American (8%). Students were in grades 2 through 6 (average grade placement was 4.2) and their average age was 9 years, 10 months. Students were characterized by poor reading performance (average standard score 77) despite average intellectual performance (average Full Scale IQ 98). No differences were found between the three groups on any demographic variable. Students' IEPs most typically addressed reading skills in the areas of passage reading (64%), comprehension (64%), decoding and phonics (55%), sight words (39%), and overall reading accuracy (36%).

Interventions. All interventions were delivered to students with learning disabilities by their special education teachers under the supervision of project staff. Students in the control group received regular reading instruction according to the annual goals on their IEP. Students in the experimental groups also received regular reading instruction but a portion of their reading time was devoted to an intervention using hypermedia-based children's literature software. Teachers were directed to provide all students, both experimental and control, with approximately the same number of minutes of instructional reading time per week.

Experimental group #1 used talking storybook programs from Disney's Animated Storybook series. These programs are characterized by medium text interactivity. That is, students can direct the program to read the entire page aloud, but it is not possible to hear individual words read aloud. Experimental group #2 used programs from the Living Books series. These programs are characterized by high text interactivity. Students can direct the program to read aloud either individual words or whole pages of text.

These intervention protocols developed in Study 3 were adapted for use in Study 4:

- *High support, whole page only:* Students read each page aloud to criterion.
- *High support, whole page and individual words:* Students read each page and 3 individual words per page to criterion.

The criterion for success was modified from 90% to "approximately 90%" to reduce demands on teachers. Students in the Disney group, experimental group #1, read with high support, whole page only. Those in the Living Books group, experimental group #2, read with high support, whole page and individual words.

Measures. At pretest and posttest, all students were assessed with portions of the Woodcock Reading Mastery Tests-Revised/Normative Update (Woodcock, 1998). This is a well known norm-referenced test with adequate reliability and validity and it is appropriate for students in kindergarten through college. Three subtests were administered:

- Word Identification, a measure of word recognition skills,
- Word Attack, a measure of decoding skills, and
- Passage Comprehension, a subtest using the cloze procedure to measure reading comprehension skills.

Also at pretest and posttest, students' attitudes toward reading were assessed via the Reading Scale of the elementary grade version of the Estes Attitude Scales (Estes, Estes, Richards, & Roettger, 1981). The Estes Attitude Scales are norm-referenced and do not require reading skills. The examiner reads aloud statements such as "Reading is fun for me," and students respond by checking "I agree," "I don't know," or "I disagree." Standard scores are available for the Estes Scales.

As in Studies 2 and 3, students were asked to read high frequency words found in the hypermedia-based children's literature programs with which they interacted. These measures were administered prior to the start of intervention with a particular program and after the intervention with that program was completed. Students read 25 words from each talking storybook. In addition, students answered eight comprehension questions after completing each program. The questions were based on the software version of the story and included five factual, two inference, and one vocabulary item.

Information about the fidelity of treatment implementation was collected through classroom observations carried out by project staff and through analysis of weekly teaching logs maintained by participating teachers. At posttest, all teachers and experimental students were interviewed to determine their perceptions of the interventions under study.

Procedures. At the beginning of the school year, participating teachers received training in (a) operation of the talking storybook programs, (b) strategies for implementation of the high structure interventions, and (c) procedures for scheduling reading instruction and data collection. A project staff member was assigned to each teacher to assist with and monitor all research tasks, and staff members visited classrooms on a regular basis throughout the study (on average, 6.8 visits per classroom).

Treatment implementation began when pretesting was finished. Teachers were directed to provide students with a total of 120 minutes of instruction for each software program over a two-week period. Project staff administered pretests for the first two programs, then returned to the classroom to administer posttests when those two programs had been completed. This procedure was then repeated for the second and third sets of programs.

Students in experimental group #1 completed six programs from the Disney's Animated Storybook series: 101 Dalmatians, Hunchback of Notre Dame, Toy Story, Hercules, Pocahontas, and Lion King. Students in group #2 completed six programs from the Living Books series: Arthur's Computer Adventure; Sheila Rae, the Brave; Stellaluna; Tortoise and the Hare; Berenstain Bears Get in a Fight; and Arthur's Teacher Trouble. An analysis of teaching log data indicated that, on average, students spent a total of 130 minutes interacting with each program, which is somewhat higher than the required minimum of 120 minutes of instruction. No difference was found between experimental groups in the amount of time spent interacting with programs. Posttesting took place when students had completed all six programs.

Results and Conclusions

Three types of analyses were conducted: analysis of experimental students' performance with the talking storybook programs, comparison of the gains students in the two experimental groups made on norm-referenced measures of reading performance, and comparisons of the gains of these groups on a norm-referenced measure of attitude toward reading.

Talking storybook program results. On average, students in the experimental groups showed a gain of 18.3 words over the six talking storybook programs with which they interacted. Thus, students made an average gain of 3.1 words per storybook. No difference was found between the students who interacted with the Living Books programs and those who interacted with the Disney series.

Comprehension was high in both groups. Across groups, students answered 41 of 48 questions correctly over 6 books. Thus, on average, students answered 6.8 of 8 questions correctly per book, an 85% accuracy rate. When the two treatment groups were compared on total number of comprehension questions answered correctly, the Living Books group was found to be superior to the Disney group ($F = 5.91$ $p = .0184$). Students in the Living Books group

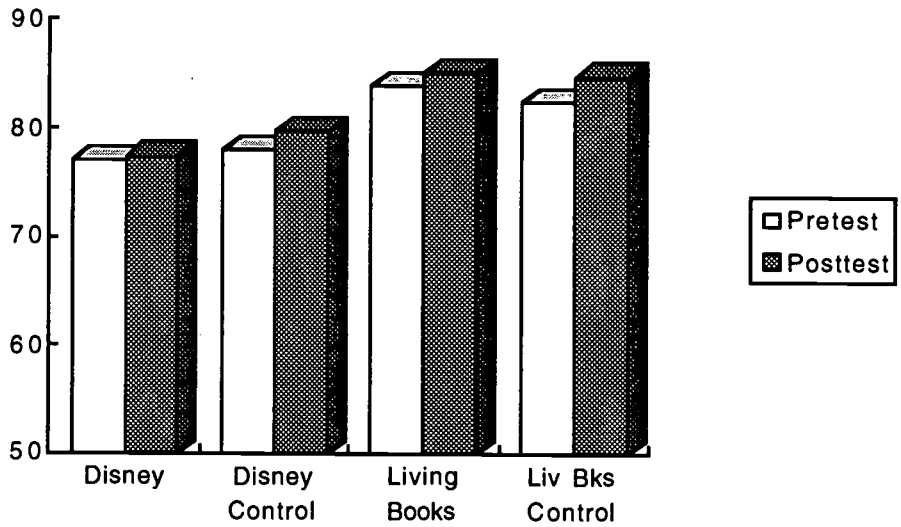
answered an average of 42.5 questions correctly whereas those in the Disney group answered an average of 39.5 questions correctly.

This result was somewhat perplexing. On first examination, it appeared that students would have less difficulty understanding the stories in the Disney programs because all were based on popular movies. However, this was not the case. Computer-based books, because of their length, cannot include as much information as a film. In the Disney programs, sometimes there are gaps in the story, sometimes the story moves very quickly from one plot episode to another, and sometimes major plot elements are poorly explained. These shortcomings apparently had a negative impact on students' comprehension performance.

WRMT-R/NU results. Inspection of the data collected at pretest suggested differences in WRMT-R/NU scores between (a) experimental group 1 (Disney) and their controls and (b) experimental group 2 (Living Books) and their controls. However, neither experimental group appeared to differ from its control group. To minimize potential difficulties, WRMT-R/NU results were analyzed across four groups, rather than three: Disney experimental group, Disney control group, Living Books experimental group, and Living Books control group. Repeated measures analyses of variance were carried out, with time as the repeated measure, and standard scores on three WRMT-R/NU subtest scores as dependent variables: Word Identification, Word Attack, and Passage Comprehension.

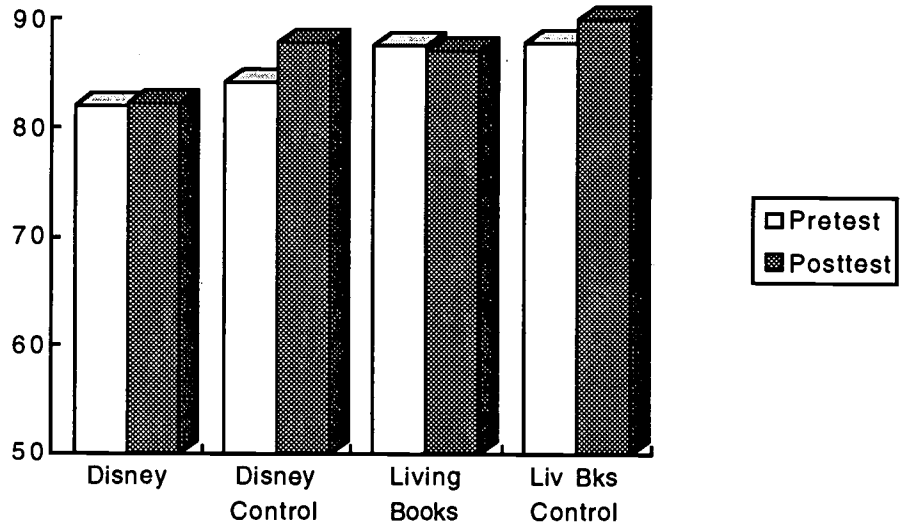
On the Word Identification subtest, differences were found between groups ($F = 4.338$, $p = .0070$) and between times ($F = 11.854$, $p = .0009$); there was no interaction between group and time. As Figure 2 illustrates, all groups improved in Word Identification over time. Group differences favored the Living Books experimental and control groups. Post hoc testing with Fisher's Protected LSD method revealed these differences at the .05 level: Living Books experimental group superior to the Disney experimental and control groups; Living Books control group superior to the Disney experimental group. No differences were found between the two Living Books groups (i.e., the experimental and control groups) nor between the two Disney groups.

Figure 2
WRMT-R/NU Word Identification Scores
at Pretest and Posttest, by Treatment Group



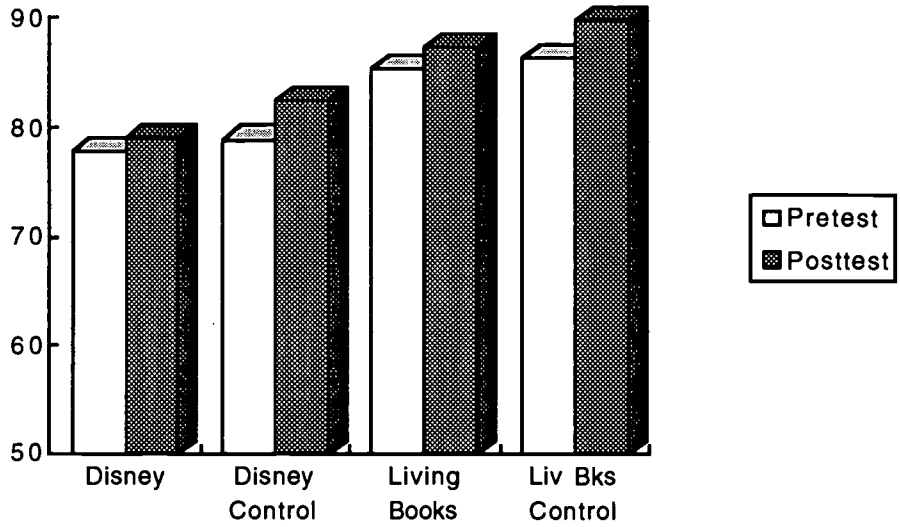
On the Word Attack subtest, differences were found between groups ($F = 2.822$, $p = .0441$). There was no difference between times and no interaction. As Figure 3 illustrates, group differences again favored the Living Books experimental and control groups. Post hoc testing with Fisher's Protected LSD method revealed these differences at the .05 level: Living Books experimental and control groups superior to the Disney experimental group. No differences were found between the two Living Books groups (i.e., the experimental and control groups) nor between the two Disney groups.

Figure 3
WRMT-R/NU Word Attack Scores
at Pretest and Posttest, by Treatment Group



Results for the Passage Comprehension subtest were essentially the same as those for Word Identification. Differences were found between groups ($F = 5.513$, $p = .0017$) and between times ($F = 10.917$, $p = .0014$); there was no interaction. As Figure 4 illustrates, all groups improved in Passage Comprehension over time. Group differences favored the Living Books experimental and control groups. Post hoc testing with Fisher's Protected LSD method revealed these differences at the .05 level: Living Books experimental group superior to the Disney experimental group; Living Books control group superior to the Disney experimental and control groups. No differences were found between the two Living Books groups (i.e., the experimental and control groups) nor between the two Disney groups.

Figure 4
WRMT-R/NU Passage Comprehension Scores
at Pretest and Posttest, by Treatment Group



Estes Attitude Scales results. The analysis model used for the WRMT-R/NU results was also employed for results of the Reading Scale from the Estes Attitude Scales. A repeated measures analysis of variance was carried out, with time as the repeated measure, and the Reading Scale T score as the dependent variable. Results indicated no differences between groups, no differences between times (pretest and posttest), and no interaction between group and time. As Table 4 illustrates, the mean T scores of all groups approximated the scale's mean (T = 50) at both pretest and posttest.

Table 4
Reading Scale T Scores at Pretest and Posttest, by Treatment Group

Group	Pretest	Posttest
Disney	48.138	48.897
Disney Control	48.357	52.500
Living Books	47.741	46.667
Liv Bks Control	51.308	49.308

Conclusions. In this study, students who interacted with talking storybook programs under high instructional support conditions made modest

gains in reading skills: on average, 3.1 words per storybook. This result is less impressive than what would be expected from the findings in Study 3. In that study, students working under high support conditions acquired on average 8.8 words per book when using programs with medium text interactivity and 9.6 words per book when using programs with high text interactivity. One difference between the two studies lies in the methodologies. In Study 3, Project LITT staff delivered the interventions. In this study, the intervention was delivered by special education classroom teachers. Project staff were able to focus on the instructional situation where students interacted with the talking storybook programs; classroom teachers, in contrast, had many other competing responsibilities.

When experimental and control group students were compared on a norm-referenced measure of reading achievement, no differences were found. Although all groups showed improvement from pretest to posttest in sight word identification and passage comprehension skills, students who used the talking storybook programs did not show greater gains than their peers who received the regular instructional program. Thus, although talking storybook programs did not prove to be a superior intervention, it appears that this approach is just as useful as more traditional approaches to reading instruction.

Teachers who participated in the study reported that their students made gains in fluency and self confidence. Unfortunately, these variables were not assessed by the measures employed in this study. Students did not show any improvement in their attitude toward reading over time, most likely because initial attitudes were positive. All of the teachers and most of the students in the study said that they would like to use similar talking storybook programs in the future. Teachers did caution, however, that talking storybooks alone are not sufficient. They should be used as part of a comprehensive reading program. In addition, teachers said that high instructional support must be provided if students are to learn successfully.

PHASE FOUR

Phase Four of Project LITT involved a replication of Study 4 with a different population: Spanish-speaking students with learning disabilities who are receiving bilingual special education services. However, because there are a limited number of bilingual special education programs in the San Diego area, a large-scale study was not feasible.

Study 5: Effects of Bilingual Hypermedia-Based Children's Literature on the Reading Performance of Bilingual Students with Learning Disabilities

Study 5 was a small-scale, naturalistic investigation of the effectiveness of representative types of bilingual hypermedia-based children's literature programs on the reading performance of bilingual students with learning disabilities. Study 4 was conducted in the Spring 1999 semester. In order to examine the effectiveness of this body of software in realistic classroom situations, bilingual special educators were trained to deliver the high structure instructional intervention developed in Study 3 to the students they served in special education classrooms.

Methodology

Participants. Three special educators teaching in bilingual (Spanish) classroom programs at the elementary level were invited to participate. These teachers nominated 17 students meeting the following identification criteria: (a) identified by the district as having a specific learning disability, (b) identified by the district as a Spanish speaker and English language learner, (c) enrolled in grades 1 through 6, and (d) having one or more IEP goals in the area of reading. Fourteen students were selected; one student in each classroom was randomly selected and assigned to the control group. The remaining 11 students were assigned to the experimental group. Because the study was completed in a relatively brief time, no attrition occurred.

All students were Hispanic. All received services in resource programs. All but one of the students were classified by their districts as NES (non-English-speaking) or LEP (limited English proficient). All but one were learning to read in Spanish, rather than in English or in both languages.

The 11 students in the experimental group included three females and eight males. Students were in grades 1 through 6 (average grade placement

was 3.9) and their average age was 9 years, 7 months. As a group, these students were characterized by poor reading performance (average standard score 82) despite average intellectual performance (average standard score 93). With one exception, English language abilities were not well developed. Language classifications of students in both the experimental and control groups are described in Table 5.

Table 5
Students' Language Classifications

Spanish Classification	English Classification	Exper. (n = 11)	Control (n = 3)
Limited Spanish Speaking	Non-English Speaking	3	3
Limited Spanish Speaking	Limited English Proficient	3	
Fluent Spanish Speaking	Limited English Proficient	4	
Fluent Spanish Speaking	Fluent English Speaking	1	

The three students in the control group included one female and two males. One student was in grade 1, one in grade 2, and one in grade 3. Their average age was 7 years, 11 months. Like those in the experimental group, these students were characterized by poor reading performance (average standard score 77) despite average intellectual performance (average standard score 92.

Interventions. All interventions were delivered in Spanish by the bilingual special education teachers under the supervision of project staff. Students in the control group received regular reading instruction according to the annual goals on their IEP. Students in the experimental group also received regular reading instruction but a portion of their reading time was devoted to an intervention using bilingual hypermedia-based children's literature software. As in the previous study, teachers were directed to provide all students, both experimental and control, with approximately the same number of minutes of instructional reading time per week.

Experimental group students used four different talking storybook programs, three from the Living Books series and one from the CD's Story Time series. The Living Books programs offered high text interactivity and those in the CD's Story Time series medium text interactivity. All programs included both English-language and Spanish-language versions of the story, although

students interacted only with the Spanish-language versions. Teachers selected three Living Books programs for their students from these choices: Arthur's Teacher Trouble; Berenstain Bears Get in a Fight; Harry and the Haunted House; Little Monster at School; and Sheila Rae, the Brave. Teachers also selected one CD's Story Time program from these possibilities: Funny Business/El león y el hipo; Best Friends' Club/La búsqueda del tesoro; and In and Out of Trouble/Problemas en el Cañón Zuni. Order of the books was counterbalanced so that each teacher included the CD's Story Time program (medium text interactivity) at a different point in the instructional sequence.

The intervention protocols developed in Study 3 and adapted for use in Study 4 were used in Study 5:

- *High support, whole page only:* Students read each page aloud to criterion.
- *High support, whole page and individual words:* Students read each page and 3 individual words per page to criterion.

As in Study 4, the criterion for success was approximately 90%. Teachers provided high support, whole page and individual words when students read the Living Books programs and high support, whole page only when students interacted with the CD's Story Time programs.

Measures. At pretest and posttest, all students were assessed with portions of the Batería Woodcock-Muñoz-Revisada (Woodcock & Muñoz-Sandoval, 1996), the Spanish-language version of the Woodcock-Johnson Psycho-Educational Battery-Revised. The Batería is appropriate for Spanish-speaking students in kindergarten through college. Three subtests were administered:

- Identificación de letras y palabras (Letter-Word Identification), a measure of word recognition skills,
- Análisis de palabras (Word Attack), a measure of decoding skills, and
- Comprensión de textos (Passage Comprehension), a subtest using the cloze procedure to measure reading comprehension skills.

Also at pretest and posttest, students' attitudes toward reading were assessed via a Spanish-language version of the Reading Scale of the elementary grade version of the Estes Attitude Scales (Estes, Estes, Richards, & Roettger, 1981). The Reading Scale used in Study 4 was translated into Spanish by a Spanish-speaking project staff member, then backward translated

to English to assure fidelity with the original version. Directions to be read to students were also translated into Spanish.

As in Study 4, students were asked to read high frequency words found in the hypermedia-based children's literature programs with which they interacted. These measures were administered prior to the start of intervention with a particular program and after the intervention with that program was completed. Students read 25 words from each talking storybook. In addition, students answered eight comprehension questions after completing each program. The questions were based on the software version of the story and included five factual, two inference, and one vocabulary item. All measures were in Spanish.

Information about the fidelity of treatment implementation was collected through classroom observations carried out by project staff and through analysis of weekly teaching logs maintained by participating teachers. At posttest, teachers were interviewed to determine their perceptions of the interventions under study.

Procedures. At the end of the Fall 1998 semester, participating teachers received training in (a) operation of the talking storybook programs, (b) strategies for implementation of the high structure interventions, and (c) procedures for scheduling reading instruction and data collection. A project staff member was assigned to each teacher to assist with and monitor all research tasks, and staff members visited classrooms on a regular basis throughout the study.

Treatment implementation began in Spring 1999 as soon as project staff had administered the three Batería subtests and reading attitude scale to students. Teachers administered pretests prior to beginning each program and posttests when each program was completed. After the fourth program was completed, project staff administered the Batería subtests and reading attitude scale posttests.

Teachers were directed to provide students with a total of 120 minutes of instruction for each software program over a two-week period. An analysis of teaching log data indicated that, on average, students spent a total of 150 minutes interacting with each program, which is higher than the required minimum of 120 minutes of instruction. However, it should be noted that one teacher spent much more time per program than the others. Her students

averaged 200 minutes per book whereas the students in the other classrooms averaged 121 minutes per book.

Results and Conclusions

Because of the small number of students involved in this study, only descriptive analyses were conducted. These included analyses of students' gains with the talking storybook programs, on the norm-referenced measures of reading performance, and on the measure of attitude toward reading.

Talking storybook program results. On average, students in the experimental groups showed a gain of 13.7 words over the four talking storybook programs with which they interacted. Thus, students made an average gain of 3.4 words per storybook. This is approximately the same gain as students made in Study 4 (3.1 words per book).

Comprehension was high. Students answered 27 of 32 questions correctly over 4 books. Thus, on average, students answered 6.7 of 8 questions correctly per book, an 84% accuracy rate. Again, this accuracy rate approximates that of students in Study 4 (85%).

Batería results. Table 6 presents pretest and posttest Batería standard scores for the experimental and control students. Inspection of the data suggests that experimental students made minimal gains in only one area, Letter-Word Identification. The number of students in the control group is so small that it would not make sense to draw even tentative conclusions about their performance.

Table 6

Pretest and Posttest Scores on the Batería Woodcock-Muñoz-Revisada

	Experimental (n = 10)		Control (n = 3)	
Subtest	**Pretest**	**Posttest**	**Pretest**	**Posttest**
Letter-Word Identification	97.5	99.2	84.0	94.3
Word Attack	87.6	84.4	68.0*	70.0*
Passage Comprehension	76.6	76.5	74.3	73.7

* n = 2

Attitude scale results. As Table 7 shows, both the experimental and control students appear to have made small gains in attitude toward reading

during the course of the study. Attitudes of the experimental students appear quite positive. For example, at pretest, their average score was 23.1 out of a possible 30 points. The attitudes of control students seem less positive. It is possible that the younger ages of these students and their resulting lack of experience with reading influenced their views.

Table 7
Raw Scores for Spanish-Language Reading Attitude Scale at Pretest and Posttest

Group	Pretest	Posttest
Experimental (n = 10)	23.1	25.2
Control (n = 3)	16.0	18.0

Conclusions. In this study, students who interacted with talking storybook programs under high instructional support conditions made modest gains in reading skills: on average, 3.4 words per storybook. This result is approximately the same as that achieved by English-speaking students in Study 4. On norm-referenced measures of reading achievement, experimental students showed some improvement in Letter-Word Identification skills over time, although no progress was evident in Word Attack or Passage Comprehension skills. Both experimental and control students seemed to improve in attitude toward reading from pretest to posttest.

Teachers who participated in the study reported that their students made gains in fluency, self confidence, and comprehension. Unfortunately, fluency and self confidence were not directly assessed by the measures employed in this study. Our reading comprehension measure, the Passage Comprehension subtest on the Batería, did not detect improvements in this area. Teachers reported that all of the students enjoyed working with the talking storybook programs. All of the teachers said they would continue to use these programs but, like the teachers in Study 4, they cautioned that talking storybooks must be used under the direct supervision of the teacher if students are to benefit.

CONCLUSIONS AND RECOMMENDATIONS

It is possible to draw some overall conclusions from the results of the five studies conducted under Project LITT about the usefulness of hypermedia-based children's literature software in classroom reading programs for students with learning disabilities. This body of software, better known as talking storybook programs, appears to be one of several potentially useful tools for improving reading performance for this population of students. The section that follows summarizes results related to the effectiveness of this software. The next two sections provide recommendations for selecting talking storybooks and suggestions for their use as part of the classroom reading instruction program.

Effects of Talking Storybooks on Reading Performance

It is clear from the results of Study 2 of Project LITT that, when students with learning disabilities engage in unstructured interactions with talking storybook software, their reading performance is not enhanced. When left to direct their own interactions with this software, students chose to spend the majority of their time engaged with non-reading aspects of the program. This lack of attention to the instructional task was reflected in their minimal gains in reading recognition skills in Study 2: 2.4 words per program.

When structured support was provided to students in Study 3, their time on task increased as did the gains they made in reading skills. In fact, the number of words learned per talking storybook program appeared directly related to the amount of instructional support provided.

The high support instructional strategies developed and refined in Study 3 were tested in typical special education classrooms in Studies 4 and 5. In Study 4, 19 special education teachers provided high instructional support to 56 students with learning disabilities. In Study 5, 3 bilingual special educators provided high instructional support to 11 bilingual students with learning disabilities. Although students learned from their interactions with the talking storybook programs, their gains were not as great as those that occurred in Study 3. One explanation for this is that the instruction delivered by classroom teachers had less intensity than that delivered by project staff in Study 3. Table 7 summarizes the gains students made in the various studies in Project LITT.

Table 7

Word Recognition Gains over Four Different Studies

Study	Type of Support	Page/Words	Reading Gains
Study 2	None	varied	2.4 words
Study 3	Moderate	page	4.8 words
	Moderate	page, words	6.8 words
	High	page	8.8 words
	High	page, words	9.6 words
Study 4	High	varied	3.1 words
Study 5	High	varied	3.4 words

One of the most encouraging findings from Project LITT's research is that talking storybook software is a useful option for teachers to consider including in classroom reading programs for elementary grade students with learning disabilities. Although students who interacted with these programs in Study 4 did not experience greater gains on norm-referenced measures of reading than students who continued with their regular reading programs, neither were their gains inferior. Talking storybook programs, as part of the total reading program, contributed to students' overall reading skills development.

Another important consideration is that teachers reported student gains in reading fluency and self confidence. Unfortunately, however, we did not measure these critical variables. Further research on the use of talking storybook programs should include assessment of reading speed and fluency as well as student self concept and self confidence.

Recommendations for Selecting Talking Storybook Programs

Special education teachers of students with learning disabilities had several opportunities throughout Project LITT to share their insights about talking storybook software. Following are the major recommendations teachers offered for the selection of software appropriate for use in classroom reading instruction.

1. Talking storybooks are typically rich and engaging programs that appeal to students, keep their attention, and motivate them. However, beware of programs with more entertainment than educational value.

2. Select programs that are enhanced versions of excellent storybooks for children. Don't settle for poor or mediocre children's literature because it is found on a CD-ROM disc.
3. Give preference to programs where the focus is on the story (rather than on dazzling graphics, superfluous hot spots, or unrelated activities).
4. Choose programs that are appropriate for students' ages in content, text, graphics, and narration. Avoid programs where one element (e.g., the content of the story) is clearly discrepant from another element (e.g., the graphics).
5. Consider the readability level of the story and other characteristics of the text (e.g., appearance, interactivity).
6. Carefully evaluate the graphical components of the program and whether they enhance or diminish the reading experience.
7. Whenever possible, select programs that are both age-appropriate and skill-appropriate for students.
8. Select programs with useful instructional features such as writing activities; avoid programs where game-like activities interfere with the story.
9. Look for programs where teachers can control important instructional parameters such as the size of the text and the speed at which text is read aloud.

Recommendations for Classroom Reading Instruction

In addition to suggesting that great care be taken in the selection of talking software programs, teachers made two other important recommendations.

The first is that talking storybook programs should be incorporated as one part--but only one part--of the classroom reading program. Students enjoy the programs, they are motivated to interact with them, and they appear to benefit from that interaction. However, talking storybooks alone are not a complete reading program. They are best seen as an engaging addition to instruction, one that increases students' enthusiasm for the reading process.

The second major recommendation that teachers made is that high instructional support is necessary for students to derive benefits from talking storybook programs. Without supervision and support, students will not attend to

the reading task. Teachers found that the high support conditions used in Study 4 and 5 were successful in focusing students' attention on the task and thereby providing them with the opportunities needed to interact with the text portions of the talking storybook programs.

DISSEMINATION EFFORTS

Activities and research findings of Project LITT have been disseminated in two ways. The first method includes traditional dissemination modes such as conference presentations and journal publications. The second method, less traditional, is dissemination on the World Wide Web.

Conference Presentations

Project LITT staff have disseminated information about Project LITT at more than a dozen state and national conferences. Our presentations have targeted a variety of audiences including special education teachers, teacher educators, and researchers (e.g., Council for Exceptional Children Conference), special education technology practitioners (e.g., the Closing the Gap and California State University, Northridge Conferences), and parents of individuals with learning disabilities (Learning Disabilities Association Conference).

Project LITT conference presentations are listed here in chronological order:

- Lewis, R. B., & Ashton, T. (1997, February). *Hypermedia-based children's literature: Is it appropriate for students with learning disabilities?* Paper presented at the 1997 Learning Disabilities Association International Conference, Chicago, IL.
- Lewis, R. B., Ashton, T., Kieley, C., & Debol, M. (1997, February). *Hypermedia-based children's literature: Is it appropriate for students with learning disabilities?* Paper presented at the 1997 International Technology and Media Division Conference, San Jose, CA.
- Lewis, R. B., & Ashton, T. M. (1997, October). *Hypermedia-based children's literature programs: Help or hindrance to students with learning disabilities?* Paper presented at the annual Closing the Gap Conference, Minneapolis, MN.
- Ashton, T. M. (1997, November). *Enhancing home/school collaboration through interactive CD-ROM storybooks.* Paper presented at the annual West Coast Special Education Conference, Anaheim, CA.
- Ashton, T. M., Lewis, R., & Haapa, B. (1998, January). *Interactive books on CD-ROM: Effective tools for students with learning*

disabilities? Paper presented at the annual Technology, Reading, and Learning Difficulties Conference, San Francisco, CA.

- Ashton, T. M. (1998, February). *Talking storybooks on CD-ROM: Useful tools for at home instruction?* Paper presented at the annual California State Federation Council for Exceptional Children Conference, Long Beach, CA.
- Lewis, R. B., & Debol, M. (1998, March). *Interactive books on CD-ROM: Effective tools for teaching reading to students with learning disabilities?* Paper presented at the annual Learning Disabilities Association Conference, Washington, DC.
- Lewis, R. B., & Ashton, T. M. (1998, March). *The Project LITT website: Interactive books on CD-ROM for students with learning disabilities.* Paper presented at the 1998 "Technology and Persons with Disabilities" Conference, Los Angeles, CA.
- Lewis, R. B., Ashton, T. M., Debol, M., & Kieley, C. (1998, March). *Interactive books on CD-ROM: Effective tools for teaching reading to students with learning disabilities?* Paper presented at the annual Learning Disabilities Association International Conference, Washington, DC.
- Lewis, R. B., & Ashton, T. M. (1998, April). *Interactive books on CD-ROM for students with learning disabilities.* Paper presented at the annual Council for Exceptional Children Conference, Minneapolis, MN.
- Lewis, R. B., Fayman, C., & Ashton, T. M. (1998, June). *The Project LITT website: Hypermedia-based literature for students at risk.* Internet poster session presented at the annual NECC Conference, San Diego, CA.
- Lewis, R. B., Kieley, C., & Ashton, T. M. (1998, October). *Talking storybook software programs for students with learning disabilities.* Poster session presented at the annual conference of the Council for Learning Disabilities, Albuquerque, NM.
- Lewis, R. B., & Ashton, T. M. (1998, October). *Effects of computer use on students with learning disabilities: Implications for assessment.* Paper presented at the annual conference of the Council for Educational Diagnostic Services of the Council for Exceptional Children, Las Vegas, NV.

- Lewis, R. B., Ashton, T. M., & Debol, M. (1999, January). *Teaching reading to students with learning disabilities: The effectiveness of talking storybook programs.* Paper presented at the annual Technology, Reading, and Learning Difficulties Conference, San Francisco, CA.
- Lewis, R. B., & Ashton, T. M. (1999, March). *Interactive books on CD-ROM and reading instruction for students with learning disabilities: What are your views?* Paper presented at the 1999 "Technology and Persons with Disabilities" Conference, Los Angeles, CA.
- Lewis, R. B. (1999, October). *Literacy skills for students with learning disabilities: Are talking storybooks effective?* Paper presented at the annual Closing the Gap Conference, Minneapolis, MN.
- Lewis, R. B. (2000, March). *Talking storybook programs for students with learning disabilities.* Paper presented at the 2000 "Technology and Persons with Disabilities" Conference, Los Angeles, CA.

Publications

Project findings have been disseminated in a variety of publications including proceedings of the annual California State University, Northridge Conference; proceedings of the National Educational Computing Conference; *Closing the Gap;* and an article prepared for the technology feature sponsored by the LD Online website. Additional manuscripts are in preparation, including at least one summarizing the results of all studies and offering recommendations to practitioners.

Publications related to Project LITT are listed here in chronological order:

- Lewis, R. B., & Ashton, T. M. (1998, March). The Project LITT website: Interactive books on CD-ROM for students with learning disabilities [web document]. In *Conference proceedings on-line: 1998 "Technology and Persons with Disabilities" Conference.* Available: http://www.dinf.org/csun_98/csun98_023.htm
- Lewis, R. B., Fayman, C., & Ashton, T. M. (1998). The Project LITT website: Hypermedia-based literature for students at risk. In *Conference proceedings, NECC '98 National Educational Computing Conference* (pp. 257-258). Eugene, OR: National Educational Computing Association, Inc. [Also available in CD-ROM]

- Lewis, R. (1998). Reading software for students with learning disabilities: Hypermedia-based children's literature [web document]. In *LD Online*. Available: http://www.ldonline.org/ld_indepth/technology/lewis_rdgsftware.html
- Lewis, R. B., & Ashton, T. M. (1999). Interactive books on CD-ROM and reading instruction for students with learning disabilities: What are your views? [web document]. In *Conference proceedings on-line: 1999 "Technology and Persons with Disabilities" Conference.* Available: http://www.dinf.org/csun_99/session0027.html
- Lewis, R. B. (1999/2000). Literacy skills for students with learning disabilities: Are talking storybooks effective? *Closing the Gap, 18*(5), 1, 8, 33.
- Lewis, R. B. (2000). Talking storybook programs for students with learning disabilities. [web document]. In *Conference proceedings on-line: 2000 "Technology and Persons with Disabilities" Conference.* Available: http://www.csun.edu/cod/conf2000/proceedings/0211Lewis.html

Dissemination on the World Wide Web

Project LITT website. The Project LITT website was first established in October 1996 to publicize Project LITT activities and to solicit assistance in the identification of hypermedia-based children's literature programs. It was totally revamped in 1997 and again in 1999. The url for this website is:

http://edweb.sdsu.edu/SPED/ProjectLITT/LITT

This site contains two major sections. The first, Information about Project LITT, explains the project's purposes, describes the type of software under study, and provides brief summaries of project research. The second section, Software Profiles, is designed for teachers and other professionals who are interested in learning more about hypermedia-based children's literature programs. This part of the site presents detailed Software Profiles for 300 children's stories identified in Project LITT's nationwide software search. Profiles can be accessed in two ways. First, several lists are available to users (e.g., an alphabetical list of programs by title, a listing of programs available in languages other than English). Second, it is possible to search the Project LITT database for specific programs by language, readability estimate, text interactivity level, and level of interactivity with graphics. Each Software Profile

provides several types of information about the program including the story's length and estimated readability level, language(s) in which the story is told, summary of the story, ratings for text and graphics interactivity, and program features.

LD Online's Technology Feature with "Ask the Expert." In October 1998, the LD Online website's feature topic was technology. Project LITT participated in this special program in two ways. First, an article describing project activities and results was posted on the website. That article remains available in LD Online's archives:

http://www.ldonline.org/ld_indepth/technology/lewis_rdgsftware.html

Second, Project LITT's director served as one of the experts in "Ask the Expert," a week-long interactive bulletin board where questions about technology could be posted. The messages appearing on that board remain available in LD Online's archives:

http://weta.org/cgi-bin/ldonline/techate

Closing the Gap's Post Conference Networking. In fall of 1999, the Closing the Gap website hosted a new feature, Post Conference Networking. Selected presenters from the October conference hosted webpages related to their presentations and responded to questions. The networking session for Project LITT remains available in Closing the Gap's archives:

www.closingthegap.com/conf/pcn/

Conference Proceedings on the Web. Three papers from presentations at the California State University, Northridge "Technology and Persons with Disabilities" Conference have been posted on the web. They are:

- Lewis, R. B., & Ashton, T. M. (1998, March). The Project LITT website: Interactive books on CD-ROM for students with learning disabilities [web document]. In *Conference proceedings on-line: 1998 "Technology and Persons with Disabilities" Conference*. Available: http://www.dinf.org/csun_98/csun98_023.htm
- Lewis, R. B., & Ashton, T. M. (1999). Interactive books on CD-ROM and reading instruction for students with learning disabilities: What are your views? [web document]. In *Conference proceedings on-line: 1999 "Technology and Persons with Disabilities" Conference*. Available: http://www.dinf.org/csun_99/session0027.html

- Lewis, R. B. (2000). Talking storybook programs for students with learning disabilities. [web document]. In *Conference proceedings on-line: 2000 "Technology and Persons with Disabilities" Conference.* Available: http://www.csun.edu/cod/conf2000/proceedings/0211Lewis.html

REFERENCES

Campbell, J. C., & Howard, V. F. (1993). Characteristics and strategies for the instruction of secondary students with learning disabilities in reading. *B.C. Journal of Special Education, 17,* 183-192.

Diegmueller, K. (1995, May 3). "Talking books" pressed into classroom service. *Education Week, 14,* 6-7.

Estes, T. H., Estes, J. J., Richards, H. C., & Roettger, D. (1981). *Estes attitude scales.* Austin, TX: PRO-ED.

Goodman, K. S. (1986). *What's whole in whole language?* Portsmouth, NH: Heinemann.

Helsel-Dewert, M., & Van Der Meiracker, M. (1987). The intelligibility of synthetic speech to learning handicapped children. *Journal of Special Education Technology, 9*(1), 38-44.

Hughes, C. A., & Smith, J. O. (1990). Cognitive and academic performance of college students with learning disabilities: A synthesis of the literature. *Learning Disability Quarterly, 13,* 66-79.

Jackson, D. S. (1994, August 22). Babes in byteland. *Time, 144,* 56-58.

King, D. F., & Goodman, K. S. (1990). Whole language: Cherishing learning and their language. *Language, Speech, and Hearing Services in Schools, 21,* 221-227.

Kos, R. (1991). Persistence of reading disabilities: The voices of four middle school students. *American Educational Research Journal, 28,* 875-895.

Lewis, R. B. (1998). Assistive technology and learning disabilities: Today's realities and tomorrow's promises. *Journal of Learning Disabilities, 31,* 16-26, 54.

Massey, H. J. (1998). Language-impaired children's comprehension of synthesized speech. *Language, Speech, and Hearing in Schools, 19,* 401-409.

Merrell, K. W. (1990). Differentiating low achieving students and students with learning disabilities: An examination of performances on the Woodcock-Johnson Psycho-Educational Battery. *Journal of Special Education, 24,* 296-305.

Santos, O. B. (1989). Language skills and cognitive processes related to poor reading comprehension performance. *Journal of Learning Disabilities, 22,* 131-133.

Smith, L. G., Siders, J. A., & Oshrin, S. E. (1987). Intelligibility of computer synthesized speech among mildly handicapped and nonhandicapped youth. In D. L. Johnson, C. D. Maddux, & A. C. Candler (Eds.), *Computers in the special education classroom* (pp. 75-79). New York: Haworth.

Werner, E. E. (1993). Risk and resilience in individuals with learning disabilities: Lessons learned from the Kauai Longitudinal Study. *Learning Disabilities Research & Practice, 8*(1), 28-34.

Woodcock, R. W. (1998). *Woodcock reading mastery tests-revised/normative update.* Circle Pines, MN: American Guidance Service.

Woodcock, R. W., & Muñoz-Sandoval, A. F. (1996). *Batería Woodcock-Muñoz-Revisada.* Itasca, IL: Riverside.

Zigmond, N., & Thornton, H. (1985). Follow-up of postsecondary age learning disabled graduates and drop-outs. *Learning Disabilities Research, 1*(1), 50-55.

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