

MULTIMEDIA CD-ROM STORYBOOKS AND TRADITIONAL PRINT
STORYBOOKS: A COMPARISON OF THE READING COMPREHENSION AND
ATTITUDE OF THIRD GRADE STUDENTS

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ABSTRACT

The purpose of this study was to compare the reading comprehension of students who read children's storybooks published on paper to the reading comprehension of a second group of students reading the same titles published on multimedia CD-ROM. This study also compared the reading attitude of students prior to reading CD-ROMs to the reading attitude of the same students after reading CD-ROMs. The subjects were 25 third grade students placed in matched pairs according to gender and performance on a reading comprehension test. Each interactive storybook has a corresponding print version with identical text and illustrations. Each subject read a total of two storybook titles in print and two storybooks titles on CD-ROM over the four week study period. CD-ROM storybooks featured student controlled word and sentence pronunciation, simultaneous highlighting of text with audio narration and vocabulary help whereas the researcher provided, when requested by a student, vocabulary and pronunciation support for the print groups. Twelve open-ended comprehension questions answered in writing were used to measure reading comprehension for each title.

Based on a ninety-five percent confidence level ($p < .05$), results of the data analysis revealed that students reading books on interactive CD-ROMs performed significantly better than students reading books in print. Results of the reading attitude survey indicated no difference in reading attitude after exposure to interactive CD-ROMs.

Additional analyses revealed that boys and subjects reading below grade level performed significantly better when reading CD-ROM books than when reading books in print. Subjects answering textually explicit and scriptually implicit questions performed significantly better with books on CD-ROM than books in print.

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CHAPTER I

INTRODUCTION

The study of interactive CD-ROMs begins with a definition and a description of an interactive CD-ROM in use in a classroom setting as well as definitions of other key terms used in this thesis. An outlining of the purpose and need for the study follows.

Definition of CD-ROM

CD-ROM or compact disc read only memory offers a practical way to store large volumes of data digitally in the form of text, databases, graphics, sound and video. Consisting of a plastic disk of approximately 12 cm in diameter and 1 mm in thickness, this high capacity and economically feasible storage medium provides access to reference materials, entertainment, educational programs and large volume software applications. CD-ROM has a capacity of 650 megabytes of data which is the equivalent of 200,000 pages of printed text or 74 minutes of quality stereo audio or 10,000 high-quality photographs (Bowers, 1994).

Multimedia, Hypermedia, Hypertext and Electronic Storybooks

The terms multimedia, hypermedia, hypertext and electronic storybooks are used to describe computer CD-ROMs. Multimedia refers to two or more media used in the same document; text, images, animation and sound such as in a story that contains narration, sound effects, written words and illustrations. Hypermedia refers to objects within the media that have an interactive interface meaning when an image, word or icon is activated by clicking the mouse on it, something happens such as a sound will play, an image, text or new screen appears. Hypertext refers to text or parts of a text such as a

word with an interactive interface. When clicked on with the mouse, something happens such as a definition appears, the word is read aloud, an animation is displayed, a sound is heard or a new screen appears. Electronic storybook refers to a work of fiction published in a multimedia, hypertext or hypermedia interface and viewed on a computer screen instead of on traditional print on paper. All of the above mentioned may or may not be sequential in format and permits the reader to view the document in the order that the reader chooses (Hult, Kalaja, Lassila, & Lehtisalo, 1990). The purpose of multimedia, hypermedia, hypertext and electronic storybooks is to assist the readers' comprehension and pronunciation through narration and vocabulary explanations, develop an appreciation of the writer's craft through games, activities and questions and promote active reading skills (Anderson-Inman, Horney, Chen, & Lewin, 1994).

Description of a Multimedia Storybook on CD-ROM

Multimedia storybooks on CD-ROM are viewed on a computer and contain illustrated versions of stories similar to a traditional storybook printed on paper. In addition, they include dramatic narration, music and sound effects and often highlight the text as the computer reads the story aloud. Some CD-ROM storybooks provide word definitions and/or say the word and/or sentence again on command. Other titles have hidden animations that act out part of the story and/or reveal supplementary dialogue upon clicking the mouse in various locations on the screen. A "few publishers include . . . supporting games, activities, and educational material that interest a child further in reading about concepts and issues raised in the story" (Bennett, 1994, p. 88).

Readers of multimedia CD-ROMs can customize their settings for a particular user to include or not the background music, to determine whether a word definition or complete story narration or pronunciation is given on a single or double mouse click or a continuous pressing down on the mouse button. In addition to English, some CD-ROMs

contain a second version of the story in a foreign language such as Japanese or Spanish. A record of the vocabulary words viewed by the reader can be kept for future reference.

Description of A Reading Session of an Electronic Storybook

The following example of an electronic story viewed on computer comes from the *ElectroText Authoring System* by Anderson-Inman, et al. (1994) and "it is sufficiently generic to apply to the reading of hypertext materials created with many of the other authoring systems currently available" (p. 279).

Josh is reading an electronically enhanced version of "The Landlady" by Roald Dahl (1978). On page 4 he encounters the word *trilby*. Unfamiliar with both its meaning and pronunciation, Josh uses his mouse to highlight the word. In an instant, a definition appears at the top of his computer screen. From the definition Josh learns that the word *trilby* refers to a soft felt hat with a dent in the top. . . By selecting additional buttons labeled "Picture" and "Say-it", Josh sees a digitized drawing of a trilby hat and hears how the unusual looking word is pronounced. Intrigued with the way the word sounds, he selects the "Say-it" button several times in a row. (p. 279)

Electronic books published on CD-ROM offer students literature in another format. Polin (1990) mentions that in both the emergent literacy and whole language view points, there is a need for students to experience reading and writing in a variety of contexts and forms. In a classroom situation, the computer with a CD-ROM storybook creates what Glasgow (1996) refers to as a "motivating, low-risk environment . . . that is relatively free from anxiety and criticism" (p. 21).

Purpose of the Study

The purpose of this study was to compare the reading comprehension of grade three students who read children's storybooks published on paper to the reading comprehension of the same titles published on multimedia CD-ROM. Research by Lamy (1990) on the effects of interactive CD-ROM books on the interest level and student-mouse interaction patterns of kindergarten to grade three students leads her to ponder:

What are the students learning? Are they gaining a greater understanding of vocabulary by listening to new words? Could they be developing better decoding skills by hearing and seeing difficult words? Is their comprehension improved by hearing words used in new contexts? (p. 3)

This study attempts to provide new insight into whether grade three students reading the CD-ROM interactive version of a story comprehend as well as students reading the traditional paper book version of the story.

In addition, this study compares the reading attitude of students prior to reading CD-ROM interactive storybooks to the reading attitude of the same students after reading CD-ROM interactive storybooks.

Need for the Study

Three of the four titles chosen for this study are produced by Discis Books, a company that has won awards such as the CD-ROM Professional Consumer Product of the Year Award (1992), the MacUser Magazine Editor's Choice Award for the Best Education Program (1990), The National Parenting Center's Seal of Approval (1991), and the California Children's Media Award (1992). In addition, over a million copies of their product has sold in thirty-five countries throughout the world as well as being adopted as official textbooks in Alabama, New Mexico, Oklahoma, Utah and Ontario (Harmony Interactive Inc., 1996).

Publishers of CD-ROM's market their products aggressively with claims of success. One such publisher, Howson and Davis (1992), states:

Everyone, especially educators, knows that learning takes place through the senses. The more senses touched, the greater the opportunity of concept development by students. The result is comprehension. (p. 12)

Yet despite the accolades and popularity of the children's CD-ROMs, there is little academic research published on the effects of interactive children's storybooks read on a computer. According to Kamil (1984), current educational practice both in the school and home, serves as a catalyst for research in improving educational methods and practices.

The electronic storybooks selected for this study (See Figure 1.1) have a corresponding traditional paper version in print with the same text and illustrations. All titles are current consumer products available for purchase through conventional mail order and/or retail channels. The computer CD-ROM software titles selected for this study are Mac/DOS/Windows 3.1/Windows '95 compatible. All four titles offer colourful illustrations and dramatic voice narration. Two of the titles are configured to offer automatic voice narration when the page is turned and the other two titles are configured to offer learner controlled narration which is activated by a mouse click on a word or sentence icon.

The following chapter will discuss some of the published research related to reading comprehension, electronic texts, and multimedia.

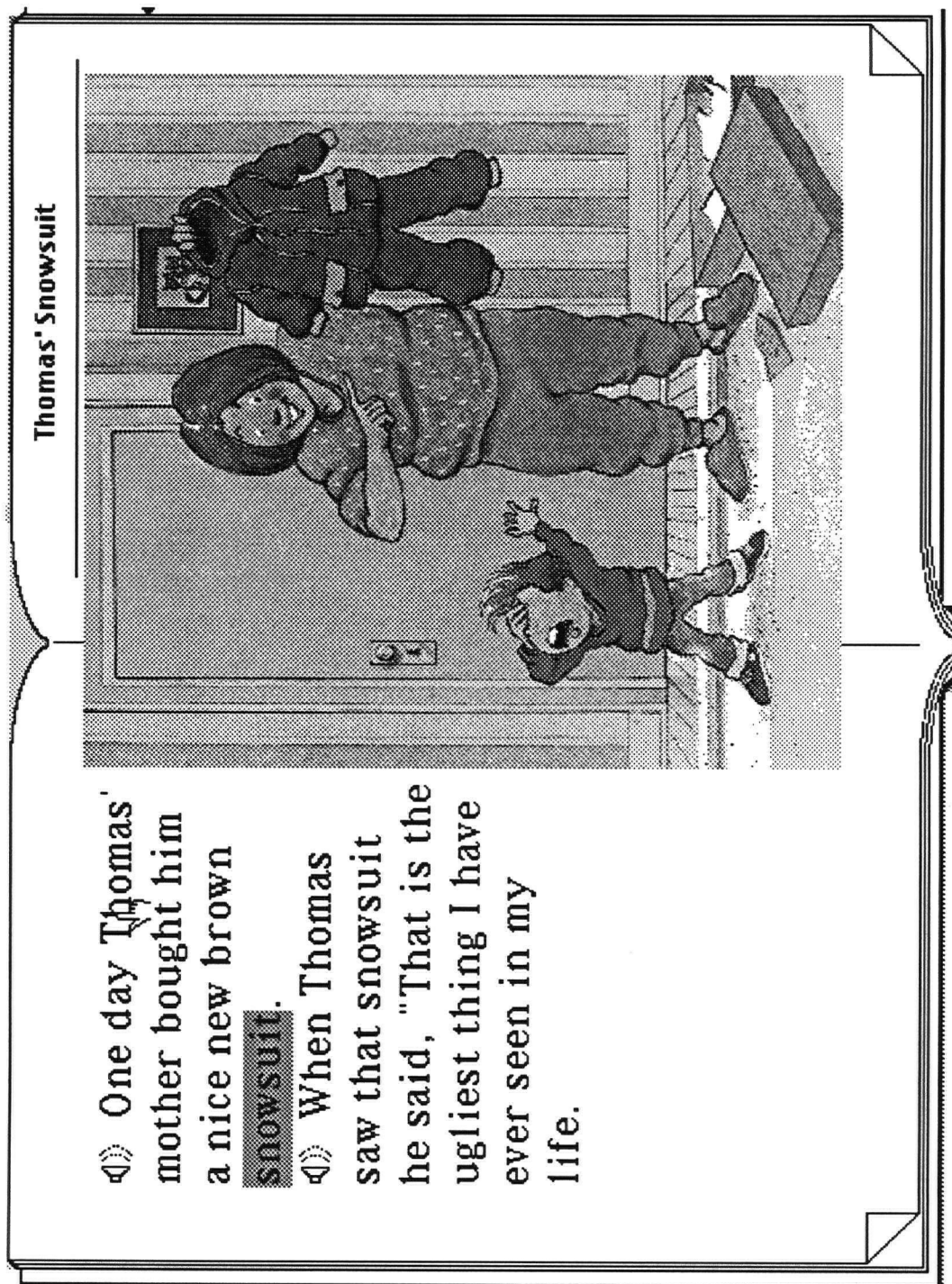


Figure 1.1 Screen Capture of the CD-ROM Storybook *Thomas' Snowsuit* by R. Munsch

CHAPTER II.

LITERATURE REVIEW

This review of literature is divided into two sections: reading-related research pertaining to traditional paper text documents and reading-related research pertaining to multimedia text documents that are viewed on a computer monitor. The first part includes a brief discussion of contemporary reading research followed by a discussion of some of the key issues related to reading: word identification, word recognition, reading comprehension, listening and reading comprehension, and reading comprehension assessment. The second part of the literature review discusses the use and effects of hypertext and multimedia in educational settings and a review of current research related to the use of CD-ROM books in the classroom.

The primary focus of this review is to discuss the many effects and considerations of interactive CD-ROMs in an elementary classroom.

Contemporary Reading Research

During the first decade of the present century, early efforts in reading research presumed that comprehension was an assumed product of correct and natural oral reading (Venezky, 1984). According to Thorndike (1917), reading is a highly active process consisting of "the same sort of organization and analytic action of ideas as occur in thinking of supposedly higher sorts" (p. 331).

Daneman (1991) defines reading as

a complex cognitive skill, consisting of the coordinated execution of a collection of oculomotor, perceptual, and comprehension processes. These include processes that direct the eye from location to location, word-level processes that

encode the visual pattern of a word and access its meaning from memory, and text-level processes that compute the semantic, syntactic, and referential relationships among successive words, phrases, and sentences in a text. (p. 512)

The primary objective of reading is to extract and forge meaning from a text source (Stanovich, 1991).

Contemporary reading research is influenced by anthropology, computer sciences, educational practice, learning theory, linguistics, cognitive and physiological psychology, and social psychology and varies from the most abstract to the most practical. It is characterized by two distinct directions: comprehending the gist of the reading process and the quest to improve methods of teaching in order to enrich education and reduce illiteracy. The catalyst for reading research is due in part to the emerging view of the reader as an active information processor and a growing interest in interdisciplinary research and practice (Kamil, 1984).

Word Identification

According to Johnson and Baumann (1984), word identification research findings are incomplete and in particular, the relationship between word identification ability and reading comprehension requires more research. "We do not yet know to what degree and in what ways mastery of the word-identification skills of phonics analysis, structural analysis, and contextual analysis contributes to reading comprehension" (Johnson & Baumann, 1984, p. 602). Empirical research can demonstrate that blending is essential to phonics and that a sequence of analysis-segmentation-blending is beneficial as well as the beginnings of words are more crucial than the middles or ends of words.

Samuels and Kamil (1984) report that reading skill, acquaintance with the word, and context determines the size of the unit used in word recognition. Whereas poor readers may endure a letter-by-letter sequence independent of the word's context, better

readers have more choices: holistic processing with known words and component-letter processing with unknown words depending on task demands (Samuels & Kamil, 1984).

The reader's age or rather the reading experience of an individual has an influence on word identification skills for as the reading experience and reading performance of an individual increases, word identification skills become less important (Daneman, 1991). The use of context helps children identify words and in particular, children of all levels use semantic cues whereas the use of syntactic cues progresses developmentally (Johnson & Baumann, 1984).

Word Recognition

In Gough's review of word recognition (1984), he states that "word recognition is the foundation of the reading process" (p. 225). Stanovich (1991) reiterates Gough's statement on word recognition being the foundation of the reading process and adds that "the ultimate purpose of reading is comprehension" (p. 418). Gains in word recognition proficiency results in expanded reading comprehension ability. Effective word recognition appears to be an essential but not adequate condition for good comprehension in both children and adults (Stanovich, 1991).

Concerning the role of context in word recognition, Daneman (1991) states that in out-of-context situations, strong readers fared better than weak readers at word recognition and at bottom-up word recognition processes. Regarding in-context situations, although strong readers fared better than weak readers at word recognition, the differences between strong and weak readers are less evident. This leads Daneman to conclude that weak readers rely more on and make more use of context to assist bottom-up word recognition processes. According to Gough (1984), as reading skill ameliorates, word recognition becomes less dependent on context .

Just and Carpenter (1987) state the word recognition process as consisting of two sub processes: word encoding or encoding the visible archetype of a printed word and lexical access or referencing its meaning in a mental dictionary. It is further postulated that word length and word frequency influence the speed at which an individual encodes and accesses meaning (Just & Carpenter, 1987). Daneman (1991) contends that "individual differences in reading ability have been attributed to differences in the reliance on contextual and phonological processes in word recognition" (p. 514). Regarding the importance of word recognition, Juel (1991) maintains that early word recognition skill is deemed momentous as early acquisition of decoding skill is an accurate predictor of later reading comprehension.

Reading Comprehension

Comprehension is experienced when new information entering the mind corresponds with the existing information stored in the mind (Samuels & Kamil, 1984). A person's ability to understand a text is then biased by their feelings concerning this information. Popular theory on comprehension contends that meaning is obtained from a text whereas Samuels & Kamil (1984) view comprehension as giving meaning to a text. Johnston (1983) views reading as a form of reader interaction with a text and that comprehension is one aspect of reading; the others being decoding, scanning and vocalizing.

Current debate on reading comprehension disputes whether comprehension is a process or a product. Most researchers (Johnston, 1983) view reading comprehension as a product of the interaction between the reader and the text.

Carrol's view of reading comprehension (1971) is a process approach involving the short-term memory and occurring instantaneously upon reception of information. The problem exists in the time intervals when testing for comprehension which may

reveal more about the memory processes instead of or as well as the comprehension processes which consist of miscue analysis and eye-movement and reaction time studies.

Royer and Cunningham (1978) established a combined view of process and product approaches to reading comprehension due to the inseparable processes involving memory and comprehension during reading comprehension. "We assume that a comprehended message will be retained in memory better than an uncomprehended message" (Royer & Cunningham, 1978, p. 36).

According to Johnston (1983), a simple rote recall of the constituents of a text is not an indicator of comprehension. Comprehension occurs when the reader is able to form reasonable links between the elements and views in the text and can present these in an alternate way. The inferences that exist in the mind of the reader are essential elements of comprehension since they permit the reader to establish meaning with words, connect text elements such as propositions and sentences and compensate for missing information (Johnston, 1983). Johnston's view of reading comprehension supports Royer and Cunningham's process and product approach.

In Johnston (1984a), the influences of prior knowledge and centrality are mentioned

comprehending involves building in one's head a model of the presumed intended meaning of a text. It is accomplished by constructing a central causal chain and organizing information from the text and from one's prior knowledge with respect to that chain. This process requires considerable use of prior knowledge in order to tie together and assign degrees of relevance or importance to text information. (p. 154)

Background information, which may consist of new word meanings, relevant facts, and experiences related to the topic and known prior to reading, assist readers learning from a text despite the method or specificity of that information (Hayes & Tierney, 1982). While the reading comprehension benefits of background information

are known, it is not known what kind of background knowledge, the quantity or quality of information a particular group of readers require nor is it known whether a specific approach in delivering the background information is more beneficial than another (Tierney & Cunningham, 1984).

On the influence of vocabulary knowledge on reading comprehension, word knowledge "is one of the best single predictors of reading comprehension performance" (Daneman, 1991, p. 524). Weak readers have smaller vocabularies than strong readers and students with smaller vocabularies have more difficulty constructing meaning in a particular text since they are more likely to encounter words for which they do not have stored meanings (Daneman, 1991).

Listening and Reading Comprehension

The relationship between listening and reading comprehension provides evidence that visual word recognition alone is unable to explain the diversity in reading abilities (Daneman, 1991). There is a definite relationship between listening comprehension skill and reading comprehension skill with proficient readers tending to be proficient listeners and mediocre readers tending to be mediocre listeners (Daneman, 1991). The relationship between listening comprehension skill and reading comprehension skill is increasingly marked as reading ability advances with a significant relationship in the early elementary grades, a moderately marked relationship in the middle grades and a notably marked relationship in adults (Daneman, 1991).

Reading Comprehension Assessment

Some of the early reading comprehension tests came to be in the search for an intelligence test. The perceived relationship between reading and intelligence led Thorndike to reach the conclusion that reading is reasoning (Thorndike, 1917). The

development and use of group silent reading tests to measure reading comprehension appears to be primarily inspired by ease of use over all else (Johnston, 1984a).

Assessing the reading comprehension of an individual necessitates interpreting a given task which is based on data from a particular text within a given text framework. The text characteristics, context and nature of the task as well as the individual's reading ability and prior knowledge are factors that influence the results (Johnston, 1983).

The use of questions is one method used to evaluate reading comprehension however, Johnston (1984a) contends that questions only allows researchers to assess the product of reading and not the process. According to Anderson and Dearborn (1952), a student must

do something else to indicate how much and how well he has understood, and that something may make the test . . . just so much less a simon-pure test of reading and thus in part a test of something else beside reading. (p. 302)

The "something else" that Anderson and Dearborn refer to above are the particular characteristics of the questions and their relevance to the text. Comprehending consists of constructing a personal interpretation of the intended meaning of a text. As part of this process, an individual assigns varying degrees of importance to the information; information that is a combination of prior knowledge and textual information.

Concerning the questions that may be asked of a reader to assess reading comprehension, Johnston (1984b), stresses the need to ask questions pertaining to the central or primary elements of a text rather than the outlying or secondary elements. In addition, Johnston (1984b) states that the issue of text availability with regards to the questioning and answering process has an effect on reading comprehension assessment with different results noted for the various kinds of questions asked. This study suggests a need for further research on the influence of memory and comprehension.

Regarding the number and kinds of questions a researcher should ask in evaluating reading comprehension, Johnston (1983) states that a higher number of test items augments the chances of inter-item contamination, however, longer tests tend to be statistically more accurate. Open-ended questions conceivably reveal more information and favour more processing of stored information than probe and free-recall type questions (Johnston, 1983).

In an attempt to develop better questioning techniques, Pearson and Johnson (1978) analyzed the relationship between the question, the answer and the text and as a result, created a taxonomy of three kinds of question-answer relationships: textually explicit questions, which require factual recall of information with the answers located directly in the text; textually implicit questions, or questions in which the answers are located in the text but in several locations and require processing to assemble the answer; and scriptually implicit questions or questions which require the use of prior knowledge as well as information in the text to answer.

A review of the literature pertaining to reading research and computer-based instruction follows.

Reading-Related Research on the Use of Computers in Educational Settings

The second part of the literature review begins with a brief review of the literature pertaining to computer-based instruction. The focus of the literature review is on the recent use and effects of hypertext and multimedia in educational settings with particular emphasis on the use of children's CD-ROM fiction titles as used in the classroom to improve reading comprehension.

In a meta-analysis of findings of 254 controlled evaluation studies based on research conducted from 1966-1986, Kulik and Kulik (1991) found that computer-based instruction, which includes all age groups and subject areas, generally produces a

positive effect on students. In addition, computer-based instruction is particularly effective in studies where treatment duration is four weeks or less resulting in an average positive effect of 0.42 standard deviations. The average effect, however, diminishes considerably in studies in which treatment duration is from several months to a year (Kulik and Kulik, 1991).

In 1983, Mason, Blanchard and Daniel cite 181 references related to computer-based reading projects, however, less than five of these references refer to published articles that report on original reading related research (Reinking & Bridwell-Bowles, 1991). Reinking and Bridwell-Bowles (1991) state the difficulties in reviewing literature related to computers in reading are due to the ever-changing technological advances in both the uses and features of computers as well as the diversity of methods employed by researchers. "Existing research reflects this diversity, but as a result it lacks depth in several areas" (Reinking & Bridwell-Bowles, 1991, p. 310). Further to the technological advances in hardware, reading software is diversifying and advancing (Reinking & Bridwell-Bowles, 1991). One promising technological advance as noted by preliminary studies, are devices which enable a computer to produce artificial or synthesized speech which may lead to an efficient strategy for augmenting decoding skills and reading fluency (Reinking & Bridwell-Bowles, 1991).

Jakobsdottir and Hooper (1995) state that in a multimedia Norwegian-as-a-second-language class, the presence of text accompanied by audio narration benefits the students since it may assist in identifying individual words. In the case of a Norwegian-as-a-second-language class to English-as-first-language students, the visual resemblance between the target and native languages is more evident in the written rather than the oral form which leads the researchers to state that this "may help students to understand by associating new words with their native tongue" (Jakobsdottir & Hooper, 1995, p. 55).

Computer Displayed Text and Reading Comprehension

In a study by Gambrell, Bradley and McLaughlin (1987) designed to measure the readability of children's stories presented on computer displayed text compared to the same stories presented on traditional paper text, 26 third grade and 36 fifth grade students were randomly assigned to either one of two treatments: text displayed on a computer screen and text displayed on paper. Both treatment groups displayed the text similarly with regard to the number of words per line, number of lines per page or screen and total number of pages or screens. The computer version of the text did not scroll nor did it provide supplementary audio or glossary support. Results indicated no statistically significant differences between the two treatment groups as measured by free and cued recalls of the stories.

Large, Beheshti, Breuleux and Renaud (1994) report on a study that compared a multimedia encyclopedia displayed on computer and its traditional paper counterpart in book form. The study included 120 grade 6 students assigned to one of three treatments: printed text with illustrations from the book form, CD-ROM text on screen without illustrations or audio and CD-ROM multimedia with text, illustrations, animations and no audio. Students were evaluated by a literal recall in writing and inference of information through a series of written questions. The CD-ROM text on screen group scored highest on the simple recall of information while the CD-ROM multimedia group fared best in the ability to draw inferences, "the animations appeared to help subjects better understand the topics" (Large et al., 1994, p. 526).

Vocabulary Acquisition and Reading Comprehension

Jenkins and Wysocki (1987) report that intermediate students learned the meanings of an insubstantial amount of words during a study that favoured inferring meaning from context clues. McKeown (1985) reports similar findings with low ability

students in a study designed to elucidate vocabulary word meanings after presenting them in multiple contexts. McKeown reached the conclusion that acquiring a word's meaning from textual clues is challenging for many readers, even under ideal conditions. Few readers will actually consult a dictionary under normal reading conditions and younger readers may not have sufficient skills to properly locate the word in a dictionary or glossary. Even if they do find the word, many readers may not be able to correctly match the proper meaning of the word with the particular meaning in the text (Reinking & Rickman, 1990).

Electronic texts presented on a computer have the advantage of presenting vocabulary meanings to words instantaneously, without the need to use dictionary reference skills or matching the appropriate meaning with the context clues presented in the text (Reinking & Rickman, 1990).

In a study by Reinking and Schreiner (1985), vocabulary definitions and background information, that is information on the topic and main idea of each paragraph, are key elements affecting comprehension. In this study, 104 good and poor fifth and sixth grade readers were assigned to one of four treatment groups: printed page without textual manipulations; text displayed on a screen without textual manipulations; text displayed on screen with optional student-controlled textual manipulations consisting of vocabulary assistance, background information, simplified versions of the text and main idea paragraph summaries and; text displayed on computer screen with all of the above textual manipulations being controlled by the computer and displayed before being permitted to proceed to the other texts. Results indicate that treatments offering textual manipulations fared better with obligatory computer-controlled textual manipulations achieving the highest scores, particularly for the more difficult texts.

In a study by Reinking (1988) in which the Reinking and Schreiner (1985) study is replicated with 33 good and poor fifth and sixth grade students, the factor of time spent

reading is considered. Results support the Reinking and Schreiner (1985) study in which comprehension augments when computer-mediated textual manipulations in the form of vocabulary assistance, background information, simplified versions of the text and main idea paragraph summaries are offered as a student-controlled option or an obligatory computer-controlled feature. In addition, Reinking (1988) noted readers spent more time reading computer-mediated texts than text displayed on paper. Reinking attributes the improved comprehension results "are more likely to be due to deeper or more efficient cognitive processing than to prolonged exposure to the text" (1988, p. 495).

In a study designed to measure vocabulary learning and comprehension of short informational texts on sixth grade students by Reinking and Rickman (1990), sixty students were divided into four treatment groups: traditional paper text with dictionary, traditional paper text with a glossary of target words, computer text with optional vocabulary assistance of target words and computer text with mandatory vocabulary assistance of target words. Students in the two computer text groups outperformed the paper text groups on a vocabulary test of target words and the computer text group with mandatory assistance outperformed all other groups in a reading comprehension test. There was an insignificant difference in vocabulary test results between the two computer groups which leads the authors to state that there was little benefit in providing mandatory vocabulary assistance when considering vocabulary acquisition alone.

Interactive CD-ROMs proved to be beneficial in the development of word knowledge in first grade students as measured by word transfer of new vocabulary words in the students' expressive writing (Nikkel, 1995). The focus of Nikkel's study was to document the integration and implementation of interactive children's storybooks on interactive CD-ROMs over a three month time period. In addition, Nikkel (1995) states that there were observable increases in the subjects' oral reading fluency and comprehension.

Aweiss (1994) reports that in an Arabic as a second language study, the three treatment groups with hypertext glossary support scored higher recall results than the control group without hypertext glossary support. In addition, of the three support conditions; glossary only, glossary and background knowledge, and glossary, background knowledge and verb conjugation support; requests for glossary only support were significantly higher than the other two support conditions.

Overall, these findings suggest, at least for this sample, that the vocabulary knowledge is the primary contributor to reading comprehension and that verb conjugation and background information played an insignificant role in enhancing readers' comprehension during independent reading. These results further suggest that the role both grammatical knowledge and background knowledge play in reading comprehension needs to be clarified. (Aweiss, 1994, p. 72)

Audio Support and Reading Comprehension in Multimedia

In a Reading Technology report by Rickelman and Henk (1990), the authors state the contributions audio and visual technologies can make to a literature-based reading program. Although the report does not specifically address computer multimedia, it shares some of its characteristics— "recorded audio can blend story narration with realistic sound effects and mood-appropriate background music to create an ideal atmosphere for experiencing the literature" (Rickelman & Henk, 1990, p. 682).

Montali and Lewandowski (1996) report on a study designed to compare the reading comprehension and word recognition capabilities of eighth and ninth grade students presented with short passages in three treatment conditions; text only as presented on computer monitor; audio only as listened to from a computer speaker; and bimodally or text presented on computer monitor with automatic highlighting of spoken word and corresponding audio narration. The results of the 18 average ability readers were compared to the results of the 18 below average ability readers across the three

treatment conditions. Each participant read three texts of increasing difficulty in each of the three treatment conditions for a total of nine texts each. Results indicate that below average ability readers comprehended more in the bimodal (text, audio narration and highlighting) treatment than in the text only or audio only treatment. Average ability readers comprehended best in the bimodal and text only conditions.

Baron and Kysilka (1993) state that in a study designed to measure the effectiveness of accompanying word for word digital audio narration in a CD-ROM computer-based lesson on CD-ROM technology, educational technology students were assigned to one of the three treatments; complete text without audio narration, condensed text with full audio word for word narration and complete text with full audio word for word narration. Results of the study indicate a significant gain in test scores on the post-test over the pre-test with no one treatment group outperforming the others. Noteworthy of the experiment is the number of times each group exercised the review option in order to answer the questions. The text only group had 47 reviews, the condensed text with full word for word audio narration group had 35 reviews while the full text with full word for word audio narration had only 22 reviews.

Audio and Glossary Support and Reading Comprehension

In a study by Stine (1993) on the effects of CD-ROM interactive software used as supplements to the regular whole language reading skills instruction program with sixteen second grade Chapter 1 students, the treatment group obtained significantly higher standardized posttest scores on both the reading comprehension and the vocabulary subtests than did the control group which received only instruction pertaining to the paper book versions of the same titles. The pretest standardized test scores did not reveal significant differences between the control and treatment groups. This study, which occurred over a twelve week duration, provided each student with three thirty

minute computer sessions. The treatment group had access to the corresponding paper versions of the computer interactive stories read in class. As part of the treatment, the CD-ROMs used in the study offered audio pronunciations and glossary support which were controlled by the student and accessed by mouse clicking in the appropriate area. The control group was exposed to computer drill and practice software as well as a word processing program but not the computer interactive versions of the stories.

Gretes and Green (1994) reported on a study of the READY courseware, an interactive CD-ROM reading program for low-literate adults that provides hypertext glossary support, spoken directions, pronunciation and audio narration. Both the control and the experimental groups consisted of 238 adults each matched for gender and race and both groups received between 44 and 66 hours of instruction over an 11 week period. The experimental group used the READY courseware and the control group followed the established Adult Basic Education program which consists of low level-high interest reading material, workbooks and traditional classroom instruction. Grade equivalent test scores indicated an average grade gain of 1.8 for the experimental group and .59 for the control group when the post-test results were compared to the pre-test results.

In a study by Greenlee-Moore and Smith (1996) comparing shorter and easier narrative texts and longer and more difficult narrative texts in both hypertext and traditional print books in two classes of above average grade four students, higher comprehension scores were achieved in the group reading the longer and more difficult narrative text on computer. The authors purport the results to be due to the textual manipulations found on the interactive version of the text; textual manipulations consisting of pronunciations and definitions of difficult words. Although the group reading the narratives in the traditional print format could ask for teacher help with pronunciations and meanings of difficult words, they in fact did not ask for assistance.

There were no significant differences between groups reading the shorter and easier narratives.

Hastings (1997) reported that in an exploratory study using CD-ROM talking storybooks with both audio and glossary support, second and third grade students with reading disabilities demonstrated improvement in reading comprehension measures. In addition, Hastings noted improved word recognition capabilities. Hastings used standardized tests as well as informal multiple choice tests to measure reading comprehension and sight word identification and phonological decodings to measure word recognition.

Lewin (1997b) reported on an exploratory study of computer-assisted reading software (CARS) using nine 8 and 9 year olds below their age level which included students with varying degrees of reading difficulties and English-as-a-second-language students. Study results indicated an improvement in reading age scores as measured by standardized tests (Lewin, 1997b). In a follow-up study of the talking books, 32 year 1 students of various reading abilities, achieved mean gains of 3 months or more in the students' reading age level as measured by two separate standardized tests (Lewin, 1997a).

Table 2.1 Summary of Empirical Research Findings on Computers in Education

Authors	Participants	Materials	Results
Hastings (1997)	6 second and third graders with reading disabilities	15 CD-ROMs; 5 multiple choice questions per title, standardized comprehension tests, sight word identification and phonological decodings.	Improvement in reading comprehension, especially for the second grade participants. Improved word recognition.
Lewin (1997a)	32 year one students	20 titles in 2 versions of talking book software, audio and glossary support with 1 offering pronunciation hints. Standardized tests.	Mean gains of 3 months or greater on standardized tests. Either version was beneficial.
Lewin (1997b)	9 eight and nine year olds; with reading difficulties; some are ESL.	Computer-assisted reading software books (CARS), standardized tests, criterion referenced tests and teacher observations.	Positive results in all 3 tests; gains greater than one month on standardized tests. All expressed a desire to continue using talking book software.
Greenlee-Moore & Smith (1996)	31 above average fourth graders.	Hypertext with audio and glossary support or print with optional teacher assistance. Shorter, easier narratives and longer, more difficult texts.	Shorter, easier narratives: no difference between groups. Longer, more difficult narratives: hypertext group scored higher.
Matthew (1996)	74 third graders arranged in matched pairs.	CD-ROM text compared to print version of same titles.	Story retellings: CD-ROM best. Open-ended comprehension questions: no difference.
Montali and Lewandowski (1996)	36 eighth and ninth graders: half average reading ability & half below average.	9 texts of 3 different levels of difficulty across 3 treatments: text only; audio only; and bimodal (highlighted text & audio).	Low group: bimodal better than text only and audio only treatments. Average group: bimodal comparable to text only. Average group better than below average all cases.
Large et al. (1994)	120 sixth grade students	3 groups: print with illustrations; CD-ROM text only; CD-ROM multimedia (text, animation, illustrations and without audio)	CD-ROM text only performed best on information recall. CD-ROM multimedia performed best in drawing inferences.

Gretes & Green (1994)	478 low literate adults	Control: low-level, high interest with workbooks and classroom instruction. Treatment: CD-ROM with glossary support, spoken directions, audio support & narration.	Posttest over pretest GE scores indicate average grade gain of 1.8 for treatment and .59 for control.
Stine (1993)	16 second grade chapter 1 students.	Control: whole language & print. Treatment: whole language & print & CD-ROM versions with audio and glossary assistance.	Higher standardized posttest scores for treatment on reading comprehension and vocabulary over control.
Baron & Kysilka (1993)	60 Educational Technology undergrads	3 treatments: full text & no narration; condensed text & full audio narration; and full text with full audio narration.	All treatments performed better on posttest over pretest with no one group outperforming the others.
Kulik & Kulik (1991)	Includes all age groups and subject areas.	Meta-analysis of 254 studies from 1966-1986.	Produces a positive effect. Average effects diminishes in study durations of several months to 1 year.
Reinking & Rickman (1990)	60 sixth grade students	4 treatment groups: print & dictionary; print & glossary; computer & optional glossary assistance; and computer & obligatory glossary assistance.	Computer treatments performed better as measured by vocabulary scores with computer with obligatory assistance performing best.
Gambrell, Bradley & McLoughlin (1987)	26 third graders & 36 fifth graders	Text displayed on computer (static without audio & glossary support) compared to text displayed on paper.	No statistically significant differences as measured by free and cued recall.
Reinking & Schreiner (1985)	104 good and poor fifth and sixth grade readers	4 treatments: print & no assistance; computer & no assistance; computer & optional vocabulary, background information, & main idea summaries; and computer & obligatory vocabulary, background information, main idea summaries.	Computer treatments offering assistance performed best, particularly for more difficult texts.

Multimedia and Foreign Language Learning

In a study on the use of multimedia in a Norwegian-as-a-second-language class, beginner level, (Jakobsdottir & Hooper, 1995), grade five students were placed in one of four treatment groups: text with audio narration, text only, audio narration only and text and audio narration absent. Results of the study demonstrated that students in the text with audio narration group performed best which leads Jakobsdottir and Hooper to conclude that "providing congruent text with spoken words facilitates the acquisition of listening skills during foreign language instruction" (Jakobsdottir & Hooper, 1995, p. 54).

In a hypertext study involving university age students in a beginner Arabic as foreign language class, students were exposed to four treatments: text only, text with glossary support, text with glossary and verb conjugation support and text with glossary, verb conjugation and background knowledge support. Results indicated that students with access to the three computer-mediated treatment groups produced higher recall scores than the control group, however, the analysis did not demonstrate significant differences between the means of the three treatment groups (Aweiss, 1994).

The pedagogical implications for second language learners is that hypertext lessons may benefit beginners the most since beginners were limited when they read independently due to their inability to use context clues, prior knowledge, syntactic and semantic clues in the text (Aweiss, 1994).

Brett (1997) contended that in a study designed to measure the effectiveness of computer-based multimedia for improving listening comprehension in an English-as-a-foreign-language class, 49 Spanish, French and German college level students demonstrated higher recall and comprehension levels when using multimedia compared to either audio or video with pen and paper. Six different video-based non-fiction listening texts were used in the study presented each on three media forms: audio cassette

with pen and paper, video cassette with pen and paper or CD-ROM on multimedia computer. Listening comprehension tasks such as true/false statements, arranging sentences and cloze tests were used to collect data.

Listening skill played a vital role in communication and language learning (Brett, 1997) and is conceivably "the most fundamental language skill" (Oxford, 1993, p. 205). Listening is not only a vital language and communication skill but the medium through which new language and communication is received (Brett, 1997).

Table 2.2 Summary of Foreign Language Learning in Multimedia

Authors	Participants	Materials	Results
Brett (1997)	49 undergrads in English-as-a-foreign language class	6 listening texts presented on audio cassette; video cassette or CD-ROM	Multimedia CD-ROM performed best on language recall and comprehension
Jakobsdottir & Hooper (1995)	109 fifth grade beginners in a Norwegian-as-a-second-language class	computer-based instructional unit with 4 treatment groups: text & audio narration; text only; audio narration only; and text & audio absent (only images)	text & audio narration group performed best
Aweiss (1994)	24 undergrads in a Arabic-as-a-foreign language class	computer-based lessons with 4 treatments: text only; text & glossary; text & glossary and verb conjugation; and text & glossary, verb conjugation and background information	3 text treatment groups with glossary support performed better than text only

Reading Comprehension Assessment Through Story Retellings and Open-Ended Questions

In a study of 37 matched pairs of grade three students that evaluated reading comprehension as measured by story retellings by Matthew (1997), students in the CD-ROM story group had significantly higher mean comprehension scores as opposed to the group who read the story in traditional print format. There were no statistically significant differences between the control and experimental groups as measured by open-ended questions. "Open-ended questions present a cued recall of the students' understanding of the text and focus on specific information and inferences made while reading. The static print text and unchanging illustrations facilitate the cued recall" (Matthew, 1997, p. 269).

Advantages of Hypertext Documents

Hult et al. (1990) pointed out some of the many advantages when reading hypermedia texts in their study of the English Reading Comprehension Course for Technical Sciences. The program met the students' individual needs in that it allowed them to revise certain points on an individual basis instead of listening to a non essential review in class. Students were less hesitant about asking questions they consider humiliating to a computer. Concerning time, the computer permitted the students to set their own timetables reading when, as much and as often as desired.

Greenlee-Moore and Smith (1996) reported that students reading hypertext documents have a reduced amount of "down-time" or time spent waiting for teacher assistance. The student was able to immediately access the definition a word, its pronunciation and an example in context while the teacher is working with other students. In addition, "repeated reading and audio feedback were described as two methods which could help children who were poor in reading" (Lamy, 1990, p. 100).

In an electronic storybook, text is highlighted as it is narrated in a karaoke like fashion which is useful for emerging readers, "young children and poor readers need narrated text so they can independently read the books. As the text is read, it should be highlighted so that the readers do not get lost" (Matthew, 1996, p. 76). The link between the spoken word heard from the computer speaker and its written form viewed on the computer screen provides positive and immediate reinforcement (Lewin, 1997b). The highlighting of spoken text is one of the simple visual effects made possible through computer software which have the effect of again drawing the reader's attention to the connection between the spoken word and the written form (Lewin, 1997b).

The interactive nature of the CD-ROM storybooks which contain narration, animations, sound effects and links to vocabulary definitions combine to form a unique support system for the reader which enables him or her to concentrate on the meaning of the text rather than decoding words (Matthew, 1996). The combination of text, images and sounds can ameliorate comprehension, "Students are better able to recall information when multiple modes of information are combined" (Ayersman, 1996, p. 508).

Attitude and Motivation Towards CD-ROM Storybooks

Kulik and Kulik's (1991) meta-analysis of findings of 254 computer-based instruction studies noted an increase in student attitudes towards computers and teaching. Ayersman's (1996) review of the research in hypermedia-based learning indicated that favourable attitudes are documented following hypermedia-based learning conditions, "as experience with hypermedia is acquired and as learning occurs, perceptions and attitudes toward hypermedia change, often becoming more positive" (Ayersman, 1996, p. 505).

Greenlee-Moore and Smith (1996) noted through videotape and field notes of the study, the affective behaviors of the students, "these students seemed very eager to read

their assigned book (traditional print) and to answer the comprehension questions" whereas the CD-ROM group, "children were overheard laughing out loud as they read from the computer screen or making such comments as 'I've been waiting to read this one' " (p. 61).

Stine (1993), noted higher academic reading attitudes for the treatment group in a study using interactive computer CD-ROMs to supplement the grade two Chapter 1 whole language reading program. Stine used the Elementary Reading Attitude Survey by McKenna and Kear (1990). In addition to the higher posttest results for the vocabulary and reading comprehension subtests, Stine noted "higher levels of class participation when reading, writing, speaking, and listening" (p. 85) for the treatment group using the Classroom Student Rating Scale.

In a study by Lamy (1990) on the effects of interactive CD-ROM books on the interest level and student-mouse interaction patterns of kindergarten to grade three students, Lamy noted that of the fifty students interviewed, thirty-five said they preferred the CD-ROM book to the paper book, six liked them equally well as paper books and nine preferred paper books. In addition, during a free access time outside the study, students were heard saying, "This is fun" and "I like the sound effects" (Lamy, 1990, p. 78). Nikkel (1995), in a study of the implementation and integration of interactive software in a grade one classroom, found a notable increase in motivation to read other materials, either by the same author or the same kind of book. Nikkel's findings are based on classroom observations, oral readings and writing samples as well as interviews with teachers and students.

Matthew (1996) noted no statistically significant difference in reading attitude between the control and treatment groups in a study comparing the reading attitude of grade three's who read CD-ROM interactive storybooks on computer and the control group who read the same titles in traditional paper versions. Matthew used the same

McKenna and Kear (1990) survey test as Stine (1993). Adam and Wild (1997) reported on a study which used third grade inner city participants and interactive CD-ROM storybooks and found no significant difference in attitude towards reading in general between the control and treatment groups after the treatment group read on average ten CD-ROM storybooks over a one month period. Further analysis of the treatment group into reluctant and willing reader groups revealed that reluctant readers developed a favourable attitude towards reading CD-ROM storybooks. The attitudes towards reading CD-ROM storybooks of the reluctant reader group corresponded with the attitudinal results of the willing reader group. The willing reader group maintained strong and favourable attitudes towards reading in general and towards reading CD-ROM storybooks throughout the study. Reading attitudes in Adam and Wild's study (1997) were measured with pretest-posttest questionnaires, interviews with reluctant readers and unstructured observations of the treatment group.

In a Norwegian-as-a-second-language study, students in the text accompanied with audio narration group indicated higher relevance and confidence scores on the delayed motivation survey, (Jakobsdottir & Hooper, 1995).

Table 2.3 Summary of Attitude and Motivation Findings

Authors	Participants	Materials	Results
Adam & Wild (1997)	45 third grade students from an inner city school.	11 CD-ROM story-books, Likert type questionnaires in a pre/post design, interviews and unstructured observations.	General reading attitude: no change over pre/posttest. Attitude towards reading CD-ROM books: reluctant readers with significant positive change. Willing readers: no change.
Greenlee-Moore & Smith (1996)	31 above average fourth grade students.	Video tape analyzed affective behaviour of students.	Appeared to enjoy reading print while overheard laughing out loud when reading CD-ROM books.
Matthew (1996)	74 third grade students.	McKenna & Kear's Elementary Reading Attitude Test (1990).	No significant difference between control and experimental groups.
Nikkel (1995)	2 first grade classrooms	CD-ROM through classroom observations, analysis of students' oral reading and writing samples, interviews with students and teachers.	Observable increase in motivation to read other CD-ROM books and other books on paper by same authors.
Jakobsdottir & Hooper (1995)	109 fifth grade beginner Norwegian-as-a-second-language	Delayed motivation survey.	Higher relevance and confidence scores for computer text with audio narration group.
Stine (1993)	Second grade chapter 1 students.	McKenna & Kear's Elementary Reading Attitude Test (1990).	Higher academic reading attitudes.
Kulik & Kulik (1991)	Includes all age groups and subject areas.	Meta-analysis of 254 studies from 1966-1986.	Increased student attitude towards computers and teaching.
Lamy (1990)	50 Kindergarten to third grade students.	Students interviews.	35 preferred CD-ROM to paper; 6 liked CD-ROM & print equally well; and 9 preferred print.

The Need for Hypermedia Literacy

Due to the increasing popularity of multimedia, interactive hypermedia and computers, "a new area of basic skills evolves that can be designated 'hypermedia literacy', (Andresen, 1996, p. 112). This instantaneous access to abundant source materials cultivates new teaching and learning methods as the students become the ones who decide on which content to use and how it is to be fused together (Andresen, 1996). Concerning the need to develop effective hypertext reading and navigation strategies, Rouet and Levonen (1996) stated that young students in particular, initially have weak hypertext navigation abilities however, their strategies improved considerably within a few training sessions.

Hypermedia literacy elevates the audience beyond being the recipient and processor of information, to being a participant in the content of multimedia productions. The audience no longer need to be quiet about their experiences and conclusions. By means of the new media, students can produce text, illustrations, sound and video clips and join different discussion forums and carry their interpretation further. (Fillmore, 1995, paragraph 10)

Limitations of the Research

Reinking and Rickman (1990) mentioned the possibility of the Hawthorne effect to explain why students make use of the computer text with hyperlinks to explore vocabulary definitions. Greenlee-Moore and Smith (1996) discussed the Hawthorne effect in their study as the grade four subjects used in the study had limited access to CD-ROM storybooks previous to this study. To counter this effect, a reasonable amount of time was given to students to familiarize themselves with the software.

Among participants in experimental groups, the Hawthorne effect may be present to the point that the occasion to use a computer to assist reading instruction may become a welcome curiosity (Reinking & Bridwell-Bowles, 1991). Kulik and Kulik (1991)

reported that in their meta-analysis, the positive effects of computers diminish significantly in longer studies. A "Hawthorne effect, could certainly explain the finding . . . as the treatment grows familiar, it loses its potency" (Kulik & Kulik, 1991, p. 89).

Concerning the limitations of hypertext studies in general, "there have been few attempts to study the cognitive processes involved in reading hypertext or to provide controlled evaluations of the impact of hypertext on learning . . . it may be argued that hypertext is such a versatile concept that it cannot be evaluated per se" (Rouet and Levonen, 1996, p.10).

In order to effectively evaluate hypertext, it is necessary to consider the computer used to display the text and in particular, the screen resolution and the size and shape of the fonts (Foltz, 1996). In a study that measured the reading speed of hypertext compared to paper text, reading time on a lower resolution screen with bit-mapped fonts was significantly slower compared to paper, however, on a higher resolution screen with antialiased fonts, reading speeds were equivalent for both the paper and hypertext groups (Gould, Alfaro, Fonn, Haupt, Minuto & Salaun, 1987; Gould & Grischkowsky, 1984). Several variables, some of which are edge sharpness, resolution, interline spacing and the contrast between characters and background may account for the observed slower reading from computer screens of the 80's however, with more sophisticated monitors with a large, higher resolution screen, reading from a computer can be as effective as reading from a book (Muter, 1996; Muter & Maurutto, 1991).

Problems with CD-ROMs

Lamy (1990) discussed the need for teachers to guide their students in the use of the computer and in particular, students with poor self-motivation and physical handicaps may require additional assistance. "It is not enough to place them before a computer and tell them to direct their own learning" (Lamy, 1990, p. 98).

CD-ROM books require teacher direction for students to learn how to benefit from them so as to avoid them from becoming "just another entertaining computer game" (Matthew, 1996). The sounds and animations are capable of distracting some students to the point of not reading or comprehending the story and students need to be reminded to make use of the online help features such as the hypertext link to word definitions. (Matthew, 1997) Some of the hypertext links to word definitions are not suitable for weak readers as the word definitions are too long and beyond the comprehension level of some the readers (Matthew, 1996).

Summary

The above articles demonstrate a pattern of improvement or neutrality to readers of CD-ROM books in the areas of comprehension and vocabulary building. In particular, improvements in reading comprehension can be attributed to the unique characteristics that computer-mediated text offers. Reinking and Schreiner (1985) and Reinking (1988) demonstrated the importance of textual manipulations in the form of vocabulary support and background information. The importance of computer-mediated word pronunciation and vocabulary assistance is evident when reading longer texts at a higher level of difficulty when compared to students with paper texts and optional teacher assistance (Greenlee-Moore & Smith, 1996). In addition, students reacted favourably to and appeared to enjoy reading computer-mediated texts (Lamy, 1990; Matthew, 1995; Stine, 1993).

CHAPTER III.

METHODOLOGY

The purpose of this study was to compare the reading comprehension of grade three students who read children's storybooks published on paper to the reading comprehension of a second group of grade three students reading the same titles published on multimedia CD-ROM. In addition, this study compared the reading attitude of students prior to reading CD-ROM interactive storybooks to the reading attitude of the same students after reading CD-ROM interactive storybooks. This chapter describes the methodology that was used to accomplish that purpose. Furthermore, descriptive information concerning the research design, hypotheses, sample, instrumentation, treatment, data collection procedures, and data analysis procedures follow.

Research Design

The design for this study is experimental because it permits manipulation of a treatment and allows for verification of a cause and effect relationship. This study is based in part on the research of K. Matthew (1995) and replicates some of the procedures used by her, in particular, the use of open-ended questions based on Pearson and Johnson's taxonomy (1978) and the use of the Elementary Reading Attitude Survey by McKenna and Kear (1990). The independent variable is the kind of media used in the treatment: storybooks on traditional paper book or CD-ROM multimedia storybooks viewed on a computer.

In order to determine the effect of reading storybooks published on CD-ROM, students were given a standardized reading comprehension test. The students were then placed in matched pairs based on the results of the standardized reading comprehension

test. One student from each matched pair was randomly assigned to group A and the other student assigned to group B. The students in group A were initially the control group or the group that read the first and second storybooks published on paper. The students in group B were initially the treatment group or the group that read the same first and second storybooks published on CD-ROM. The students read the two storybooks, one at a time. Upon reading a storybook, the students then wrote a reading comprehension test based on the contents of the story. The students then switched treatment groups and group A became the treatment group or the group that read the third and fourth storybooks published on CD-ROM while group B became the control group or the group that read the third and fourth storybooks published on paper. The students then wrote a reading comprehension test after each storybook reading. The results of the comprehension tests from the control groups were compared to the results of the comprehension tests of the treatment groups.

In order to measure the attitude of students reading storybooks published on CD-ROM, students completed a reading attitude survey prior to exposure to the CD-ROM storybooks. The students then completed the same reading attitude survey after reading the CD-ROM storybooks. The pre and posttest reading attitude survey results were then compared.

Hypotheses

To determine the effect of children's interactive software titles on the reading comprehension and attitude of third grade students, the following null hypotheses was examined:

1. There is no statistically significant difference between the reading comprehension of third grade students who read children's fiction titles published on CD-ROM and displayed on a computer and the reading

comprehension of third grade students who read children's fiction titles published in traditional print books.

2. There is no statistically significant difference between the posttest reading attitude of third grade students who read children's fiction titles published on CD-ROM and displayed on a computer and the pretest reading attitude of third grade students who have not read children's fiction titles published on CD-ROM and displayed on a computer.

To determine the effect of children's interactive software titles on the reading comprehension and attitude of third grade students, the following nondirectional research hypothesis was examined:

1. There is a statistically significant difference between the reading comprehension of third grade students who read children's fiction titles published on CD-ROM and displayed on a computer and the reading comprehension of third grade students who read children's fiction titles published in traditional print books.

2. There is a statistically significant difference between the posttest reading attitude of third grade students who read children's fiction titles published on CD-ROM and displayed on a computer and the pretest reading attitude of third grade students who have not read children's fiction titles published on CD-ROM and displayed on a computer.

Subjects

The subjects in the study were 28 grade 3 students chosen from a suburban elementary school in the lower mainland of British Columbia. The neighbourhood is comprised primarily of detached, single family housing with multi-family apartment buildings in one nearby area. According to the teachers of the two third grade classes, the school catchment area is very diverse from a socio-economic point of view. The subjects included all the grade 3 students from the grade 3 class and all the grade 3 students from the grade 2/3 class who returned a signed parental permission form. Of the

35 students in the two third grades classes, 28 agreed to participate however there were two dissensions prior to commencement of the study and a third dissension after reading the first storybook title as the students moved to a different school. Thirty-five subjects is considered to be a sufficient number for a study "for a sample size of 30, the normal distribution provides a reasonably good approximation of the sampling distribution of the means. So $N=30$ is used, as a rule, for inferring the shape of the sampling distribution" (Shavelson, 1996, pp. 255-256). The subjects were from the regular English stream of a large dual track French Immersion school. The K-7 school has a population of approximately 550 students of which 375 are part of the regular English stream and approximately 175 are part of the French Immersion program.

The subjects represent several ethnic groups, of which, Caucasian represents the largest segment of the school population followed by Asian. Fifteen participants speak English-as-a-first-language while 13 speak English-as-a-second-language. Of the 13 that speak English-as-a-second-language, only 7 are classified as needing support in English language instruction and participate in a pull out English language program. The criteria for determining the need for supplementary English language classes is based on informal tests with the English-as-a-second-language teacher and depend on the number of students in the school needing assistance and the time allotment of the English-as-a-second-language teacher. The subjects were placed in matched pairs according to gender and performance on a reading comprehension test given at the beginning of the study. Judging by the results of a coin toss, one member of each matched pair was randomly assigned to either group A or group B. Each group has an equal number of boys and girls. The Gates-MacGinitie Reading Test, Canadian Edition, Handscorable Booklet is used to determine the subject's reading grade level.

All participants in the study received consent forms approved by the Behavioural Research Ethics Board of the University of British Columbia. One copy was signed by a

parent and returned to the school and one copy was kept by the parents for their own records.

The school chosen for the study has a computer lab containing 20 networked Macintosh MacClassics. In addition, there are 5 Power Macintosh multimedia equipped computers. The subjects are familiar with the graphic user interface common to Macintosh computers and the function of a mouse.

Instrumentation

The instrumentation for the study consisted of a reading comprehension test, a pre/posttest reading attitude survey, four sets of open-ended posttest questions which comprised one for each story and a supplementary survey.

Gates-MacGinitie Reading Test

The subject's reading comprehension was measured using the Gates-MacGinitie Reading Test, Canadian Edition, Handscorable Booklet, Level C, Form 1 and the answers and reading grade level calculations were based on information provided in the accompanying Teacher's Manual. The Level C version of the test is designed for the grade three level.

This test was given at the beginning of the study to establish the matched pairs. The Level C test consists of two sub-tests: The Vocabulary Test ($R=.85$ to $.94$) and The Comprehension Test ($R=.85$ to $.92$). The test was given in two group settings and required a pencil. Answers were recorded directly in the booklet. The first sub-test was The Vocabulary Test and students were given 35 minutes to complete. The Vocabulary Test contains 45 items and is designed to sample the student's reading vocabulary. Each item consists of a test word followed by four words or phrases. The student must choose

the most correct answer. The test starts off with words that are easy and familiar followed by words that gradually become less common and more difficult.

The second sub-test is The Comprehension Test and 45 minutes was allocated to write this test. The Comprehension Test contains 22 different passages with 2 questions for each passage. The passages represent many subject areas, some of which are from books for children. The questions necessitate an understanding of the passages that is both explicit and implicit.

The allocated times for the tests included time for distribution of the tests and the writing of names which was 5 minutes for each test; time for instructions and practice items which was 10 minutes for The Vocabulary Test and 5 minutes for The Comprehension Test; and the remainder for the writing of the test which was 20 minutes for The Vocabulary Test and 35 minutes for The Comprehension Test.

The Scoring Key in the Gates-MacGinitie Reading Test, Canadian Edition, Teacher's Manual was used to determine the correct answers and for calculating the grade equivalents for the tests.

The Elementary Reading Attitude Survey

The reading attitude of the students was measured using The Elementary Reading Attitude Survey (Appendix III, McKenna & Kear, 1990). The test contains 10 questions that measure a student's attitude toward recreational reading and 10 questions that measure a student's attitude toward academic reading. This paper and pencil test is appropriate for grades 1 to 6. Each question is in a combination pictorial/ text format and consists of 4 drawings of the Garfield cartoon character with different body and facial expressions and a brief simply-worded statement on reading. Each statement starts the same, "How do you feel . . . ?" The different body and facial expressions are designed to depict different emotional states varying from very positive to very negative. The test

was administered in a group setting prior to the treatment and once again, at the end of the second CD-ROM storybook title. The test was not timed and took approximately 10 minutes to complete. The researcher read each item aloud twice in a slow and clear voice to the class. The students then circled the picture of Garfield that best resembles their feeling on reading on their copy of the test.

Information on the reliability of the test is stated in appendix III.

Open-Ended Questions

Open-ended questions (Appendix I) were used as posttest assessment for each storybook title. Open-ended questions conceivably reveal more information and favour more processing of stored information than probe and free-recall type questions (Johnston, 1983). "Open-ended questions present a cued recall of the students' understanding of the text and focus on specific information and inferences made while reading. The static print text and unchanging illustrations facilitate the cued recall" (Matthew, 1997, p. 269).

Pearson and Johnson's taxonomy (1978) was used to create three kinds of questions: textually explicit questions, which require factual recall of information with the answers located directly in the text; textually implicit questions, or questions in which the answers are located in the text but may be in several locations and require processing or inference to assemble the answer; and scriptually implicit questions or questions which require the use of prior knowledge as well as information in the text to answer.

Based on Pearson and Johnson's taxonomy, four textually explicit questions, four textually implicit questions and four scriptually implicit questions were created for each storybook title. A colleague familiar with the stories and reading ability of the age group used as the control and experimental groups was given information on Pearson and Johnson's taxonomy and independently verified the classification of the questions.

Additional consideration was given to Johnston's (1984b) views concerning the quality of the questions asked and in particular, the need to ask questions pertaining to the central or primary elements of a text rather than the outlying or secondary elements. A colleague verified the questions and answer key for suitability to the age group and story content. Differences were discussed and resolved.

The posttest question sheets in the study were identical in content and order as the ones represented in Appendix I, however, to allow the students more space for answers, the questions were printed on larger, legal size paper instead of the letter size paper as shown in this thesis.

Regarding the number of questions a researcher should ask in evaluating reading comprehension, Johnston (1983) states that longer tests tend to be statistically more accurate however, a higher number of items augments the chances of inter-item contamination. Twelve questions were used for each storybook title. The same questions were given on paper to both the traditional book and CD-ROM computer groups.

The tests were scored according to a three point scale using an answer key. For each correct response, a student received two points. For each partially correct response or "gist" of a story element, a student received one point (Stein & Glenn, 1979; Thorndyke, 1977). Incorrect or unanswered questions received zero points. Possible scores for the tests were from 0, the lowest score to 24 points, the highest score. Each test was initially corrected by the researcher. A colleague then rescored the tests. Scoring differences of more than one point were discussed and resolved by recording the average of the two scores.

Supplementary Survey

In order to determine the effects of owning a computer at home and borrowing books from a library might have on the results of the study, a supplementary survey was used. While walking the students to and from their classroom, the researcher asked the students verbally in an informal manner if they owned a computer at home or not and if they currently had any books checked out from the municipal or school library. The answers to these questions were then recorded on the supplementary survey (Appendix IV).

Computer

The computer used in the study was a multimedia equipped Power Macintosh. This computer surpassed the minimum hardware requirements as outlined by the CD-ROM software publishers and was able to provide quick page turns with little or no wait time.

Treatment

Students in the control group were taken out of class, one at a time, to the library resource room. Each student worked with the researcher for approximately 30 minutes, once a week for 4 weeks. Oral instructions were given to each student at the beginning. Each student read a short work of fiction and then answered the comprehension questions in writing. Students were told that spelling did not count; they were asked to write as neatly as possible. Each student repeated this process 4 times over the entire study length, once for each fiction title. Students in the control (book) group were permitted to ask for help in pronouncing a word or explaining what a word means.

To improve the internal validity of the study, the control and treatment group were switched to the effect that each subject in the study served as a control subject for two storybook titles and as a treatment subject for the other two storybook titles.

Students in the experimental group followed the same procedures as the control group with the following differences. Students were taught how to use the computer by showing where to click the mouse to start and how to get glossary and audio support. A review of the page turning procedures was given for each title. Students read the stories displayed on the computer and then they answered the comprehension questions in writing. Word pronunciation and vocabulary help were provided by the computer.

The order of events (See Figure 3.1) was title 1 with control group A, title 1 with experimental group B; title 2 with control group A, title 2 with experimental group B; title 3 with control group B, title 3 with experimental group A and title 4 with control group B, title 4 with experimental group A.

As part of the treatment, computer titles 1 and 3 were configured to offer student-controlled optional audio narration with simultaneous text highlighting as well as music and sound effects on a sentence by sentence or word by word basis as well as vocabulary support. Students initiated vocabulary support by double clicking on the word and activated word and sentence narration by clicking on the word or sentence speaker icon. Computer titles 2 and 4 were configured to offer computer-controlled audio narration with accompanying music and sound effects as well as simultaneous text highlighting activated by clicking on the page turn icon. In addition, students were able to access the student-controlled narration in order to listen to a word or sentence again as well as accessing the vocabulary support by clicking the mouse on the word once for word narration and twice for vocabulary support. To repeat the entire sentence, the student clicked once on the sentence speaker icon.

GROUP A	GROUP B
T1: <i>Thomas' Snowsuit</i> BOOK VERSION with teacher pronunciation/ word meaning assistance on request	T1: <i>Thomas' Snowsuit</i> COMPUTER VERSION with student controlled narration/ audio support
T2: <i>Tale of Benjamin Bunny</i> BOOK VERSION with teacher pronunciation/ word meaning assistance on request	T2: <i>Tale of Benjamin Bunny</i> COMPUTER VERSION with automatic narration

GROUP A	GROUP B
T3: <i>Northern Lights: The Soccer Trails</i> COMPUTER VERSION with student controlled narration/ audio support	T3: <i>Northern Lights: The Soccer Trails</i> BOOK VERSION with teacher pronunciation/ word meaning assistance on request
T4 : <i>Strega Nona Meets Her Match</i> COMPUTER VERSION with automatic narration	T4: <i>Strega Nona Meets Her Match</i> BOOK VERSION with teacher pronunciation/ word meaning assistance on request

Figure 3.1

Design Treatment Schema Illustrating Each Group's Role In Both The Control and Treatment Groups

The titles chosen for the study are based on the interest level and level of reading difficulty of the titles. Grade 3 teachers were consulted concerning the choice of titles. Consideration is given to ensure that none of the books were previously studied in class.

The titles chosen for the study and presented in the order of treatment are: Thomas's Snowsuit by Robert Munsch, The Tale of Benjamin Bunny by Beatrix Potter, Northern Lights: The Soccer Trails by Michael Arvaarluk Kusugak and Strega Nona Meets Her Match by Tomie dePaola. Two of the titles have a female main character and two of the titles have a male main character.

CD-ROM titles 1, 2 and 3 offer learner controlled audio glossary support activated by a double mouse click and pronunciation of the word in syllables, activated by a long single mouse click. CD-ROM title 4 does not offer audio glossary support nor does it offer word pronunciation in syllables however, to compensate, the researcher is available to offer glossary and pronunciation in syllables assistance to the title 4, CD-ROM group upon request. These titles do not feature animation, hidden or otherwise.

Upon completion of each set of story questions, the students are thanked and escorted back to their classroom.

Software Selection Process

The software used in the study was chosen after considering numerous characteristics, many of which are discussed in the proceeding paragraphs. Of primary consideration was the availability of the software to the teaching public through conventional computer software and book retail and mail order outlets as opposed to "in house" software and texts created specifically for the study. Each storybook title in print featured the exact same text wording and illustrations as the corresponding CD-ROM version. CD-ROM storybooks which offered supplementary narrated dialogues activated by clicking on the illustrations were not considered for this study since the print version

did not contain these dialogues. CD-ROM storybooks which offered narrated dialogue not supported by a corresponding text on the computer screen were not considered since students may get lost or frustrated in trying to find the corresponding text. CD-ROM storybooks selected for the study had automatic text highlighting of the narrated text. CD-ROM storybooks containing either automatic animation sequences or click on "hot spot" animation sequences were not considered since these features were not available to print readers. CD-ROM storybooks which contained direct links to games, Internet sites and comprehension activities in the story were not considered.

Concerning learner control of the software, CD-ROM titles allowed the students to turn the page on command, thus permitting the student to read at their own pace. In addition, the software titles used enabled the students to navigate through the story in a forward or backward direction without being obligated to listen to each page being narrated again. This feature was especially useful for students wanting to review story elements when responding to the comprehension questions. For the titles that were configured to offer automatic narration or during narration sequences activated by the students, it was important that students were able to stop the narration at any time. Students were taught how to stop the narration by clicking on a blank part of the page. Each storybook CD-ROM offered learner controlled audio support in the form of word pronunciations upon clicking the mouse in the appropriate area while three software titles offered click on audio glossary support and click on pronunciation of words in syllables. Concerning story composition, each title was a complete work of fiction containing the following story elements: plot, problem, solution, characters, events, beginning, middle and an end and recount events that were relevant and of interest to the subjects' age group.

During the software evaluation and selection process, a suburban public municipal library proved to be of invaluable assistance in being able to borrow the

software from the children's collection with minimal loan request times. The larger public municipal library in the city centre contained an equally valuable software collection, some of which was read on site on computer reading stations but the loan request delay proved too lengthy to be practical. The local school district teacher resource centre was a source of information in selecting software as it has a regional software testing and evaluation facility provided by the provincial ministry of education. Some software publishers offered free demonstration copies of their CD-ROMs however since these demonstration copies often did not contain the entire story or offer all the features of the program, their use was of limited value.

Data Collection Procedures

The data for the pre/post test Elementary Reading Attitude Survey (Appendix III) was collected by the researcher. The students were asked to indicate the Garfield expression that corresponds with their feelings on the reading statement printed below. The researcher graded the survey according to the information provided on the Elementary Reading Attitude Survey Scoring Sheet (Appendix III) with 4 points for the happiest Garfield; 3 points for the slightly smiling Garfield; 2 points for the mildly upset Garfield; and 1 point for the very upset Garfield. Results were then recorded in the appropriate sections on the Elementary Reading Attitude Survey Scoring Sheet and raw scores were then converted to percentile ranks using Table 1 of the Elementary Reading Attitude Survey Appendix.

Regarding the open-ended questions, the same data collection procedures were applied to both the control and treatment groups. The same questions were given on paper to both the traditional book and CD-ROM computer groups. Upon reading the story, students were given a sheet of paper containing 12 open-ended questions which required written answers. These questions were based on Pearson and Johnson's

taxonomy, and consisted of: four textually explicit questions, four textually implicit questions and four scriptually implicit questions for each storybook title.

Additional consideration was given to Johnston's (1984b) views concerning the quality of the questions asked and in particular, the need to ask questions pertaining to the central or primary elements of a text rather than the outlying or secondary elements.

The tests were scored according to a three point scale using an answer key. For each correct response, a student received two points. For each partially correct response, a student received one point. Incorrect or unanswered questions received zero points. Scores for the tests range from 0, the lowest score to 24 points, the highest score. Each test was initially corrected by the researcher. A colleague familiar with the stories then rescored the tests. Scoring differences of more than one point were discussed and resolved by using the average of the two scores. The scores were recorded on the question-answer analysis classification sheet (Appendix II).

Data Analysis Procedures

The data for the Elementary Reading Attitude Survey was analyzed for differences in the pre/post test results. The authors of the Elementary Reading Attitude Survey, McKenna and Kear, recommend using a pre/post difference of 5 points on either the academic or recreational scales or a 7 or 8 point difference on the total score before any real change could be assumed. The pre/post test results were analyzed using a non-directional *t*-test for paired samples.

The open-ended question data from the student answer sheets were analyzed using a non-directional *t*-test for paired samples. The 95 percent confidence level ($p < .05$) was used as the criterion level for establishing statistical significance.

CHAPTER IV.

RESULTS

This study was primarily concerned with two research questions. The first question investigated the reading comprehension of third grade students who read children's storybooks published on paper compared to the reading comprehension of a second group of students reading the same titles published on multimedia CD-ROM. The second question investigated the reading attitude of students prior to exposure to multimedia CD-ROM to the reading attitude of the same students after reading CD-ROM interactive storybooks on a computer. In addition, the reading comprehension test scores were organized into various subgroups and analyzed according to language group, (English-as-a-second-language or English-as-a-first-language); reading level, (below grade, at grade or above grade); gender, (male or female); ownership of a computer at home, (yes or no); and whether the subjects had books borrowed from a library at the time of the study. The questions used in the study were classified according to Pearson and Johnson's question-answer relationship taxonomy (1978). Throughout the study, the ninety-five percent confidence level ($p < .05$) was used as the standard for establishing statistical significance. This chapter presents the results of the data analysis of the two research questions, and the additional data analyses pertaining to the effects of various reader and question characteristics mentioned above.

Reading Comprehension

The following null hypothesis was tested in response to the first research question: There is no statistically significant difference between the reading comprehension of third grade students who read children's fiction titles published on CD-

ROM and displayed on a computer and the reading comprehension of third grade students who read children's fiction titles published in traditional print books.

A non-directional *t*-test for paired samples was used to examine the difference between the reading comprehension groups as measured by 12 open-ended comprehension questions for each title. Table 4.1 presents the results obtained when the data collected were analyzed using a non-directional *t*-test for paired samples.

Table 4.1 Results obtained from a non-directional *t*-test for paired samples on open-ended comprehension questions

CD-ROM			Print			<i>df</i>	<i>t</i>	Sig. (2-tailed)
<i>N</i>	Mean	<i>SD</i>	<i>N</i>	Mean	<i>SD</i>			
25	17.36	2.56	25	15.83	3.88	24	2.37	.026

Using open-ended comprehension questions (Appendix I) with a maximum score of 24, Table 4.1 indicates that subjects in the CD-ROM group (*N*=25) produced a mean score of 17.36 and subjects in the print group (*N*=25) produced a mean score of 15.83. The analysis produced a *t* of 2.37 which was statistically significant (*p*=.026) and, consequently, indicated that the mean for the CD-ROM group was significantly different from the mean for the print group. Subjects in the experimental group or the group that read the storybooks on CD-ROM computer performed better than subjects in the control group or the group that read the storybooks in the traditional print form.

Reading Attitude

The following null hypothesis was tested in response to the second research question: There is no statistically significant difference between the posttest reading attitude of third grade students who read children's fiction titles published on CD-ROM and displayed on a computer and the pretest reading attitude of third grade students who

have not read children's fiction titles published on CD-ROM and displayed on a computer.

The Elementary Reading Attitude Survey (Appendix III) was used to measure the reading attitude of students before and after reading children's storybooks on computer CD-ROM. The Elementary Reading Attitude Survey is comprised of two sections: the recreational reading attitude and the academic reading attitude. A non-directional *t*-test for paired samples was used to compare the posttest means to the pretest means for the recreational reading attitude of the subjects before and after reading children's storybooks published on CD-ROM and read on a computer. Table 4.2 presents the results obtained when the recreational reading attitude data collected were analyzed using a non-directional *t*-test for paired samples.

Table 4.2 Recreational reading attitude pretest-posttest results analyzed using a non-directional *t*-test for paired samples

Posttest			Pretest			<i>df</i>	<i>t</i>	Sig. (2-tailed)
<i>N</i>	Mean	<i>SD</i>	<i>N</i>	Mean	<i>SD</i>			
25	33.04	5.15	25	33.88	4.86	24	1.263	.219

The recreational reading attitude section of the Elementary Reading Attitude test (Appendix III) has a maximum score of 40. As indicated in Table 4.2, the subjects (*N*=25) earned a mean score of 33.04 on the posttest and a mean score of 33.88 on the pretest. The differences between the posttest and pretest scores as measured by a *t* of 1.263 are not significant (*p*=.219).

A non-directional *t*-test for paired samples was used to compare the posttest means to the pretest means for the academic reading attitude of the subjects before and after reading children's storybooks published on CD-ROM and read on a computer. Table

4.3 presents the results obtained when the academic reading attitude data collected were analyzed using a non-directional *t*-test for paired samples.

Table 4.3 Academic reading attitude pretest-posttest results analyzed using a non-directional *t*-test for paired samples

Posttest			Pretest			<i>df</i>	<i>t</i>	Sig. (2-tailed)
<i>N</i>	Mean	<i>SD</i>	<i>N</i>	Mean	<i>SD</i>			
25	33.60	5.61	25	33.84	4.68	.24	.247	.807

The academic reading attitude section of the Elementary Reading Attitude test (Appendix III) has a maximum score of 40. As indicated in Table 4.3, the subjects (*N*=25) earned a mean score of 33.60 on the posttest and a mean score of 33.84 on the pretest. The pretest-posttest differences as measured by a *t* of .247 are not significant (*p*=.807).

A non-directional *t*-test for paired samples was used to compare the posttest means to the pretest means for the combined recreational and academic reading attitudes of the subjects before and after reading children's storybooks published on CD-ROM and read on a computer. Table 4.4 presents the results obtained when the recreational and academic reading attitude data collected were analyzed using a non-directional *t*-test for paired samples.

Table 4.4 Combined recreational + academic reading attitude pretest-posttest results analyzed using a non-directional *t*-test for paired samples

Posttest			Pretest			<i>df</i>	<i>t</i>	Sig. (2-tailed)
<i>N</i>	Mean	<i>SD</i>	<i>N</i>	Mean	<i>SD</i>			
25	66.64	10.12	25	67.72	8.68	24	.797	.433

The combined academic and recreational reading attitude sections of the Elementary Reading Attitude test (Appendix III) has a maximum score of 80. As indicated in Table 4.4, the subjects ($N=25$) earned a mean score of 66.64 on the posttest and a mean score of 67.42 on the pretest. The differences between the pretest and posttest scores as measured by a t of .797 are not significant ($p=.433$) and, consequently, indicated no change in attitude towards reading.

Results for Hypothesis 1

Using open-ended questions, the experimental group (mean=17.36) had a higher reading comprehension score reading children's storybooks on the computer CD-ROM than the control group (mean=15.83) did reading the same titles in the traditional book in print format. The difference between the print and CD-ROM groups was significant ($p=.026$) and consequently, the null hypothesis was rejected.

Results for Hypothesis 2

The reading attitude of the students as measured by the Elementary Reading Attitude Survey (Appendix III) post exposure to CD-ROM books produced a mean score of 66.64 whereas the reading attitude of students prior to exposure to CD-ROM books produced a mean score of 67.42. The differences between the pretest-posttest scores were not significant ($p=.433$) and consequently, the null hypothesis was accepted.

Results for Additional Analyses of Reader and Question Characteristics

The reading comprehension test scores were reorganized into various subgroups and analyzed according to language group, English-as-a-second-language or English-as-a-first-language; reading level, below grade, at grade or above grade; gender, male or female; ownership of a computer at home or not; and whether the subjects had books

borrowed from a library at the time of the study. The questions used in the study were classified according to Pearson and Johnson's question-answer relationship taxonomy (1978). This section presents the additional data analyses pertaining to the effects of various reader and question characteristics mentioned above.

Language Group

Of the 25 subjects who completed the study, 7 spoke a language other than English as a dominant language and consequently, were classified as English-as-a-second-language (ESL) according to the school district's criteria. This information was provided on school registration forms as well as informal testing with an ESL teacher. These 7 students participated in specialized pull-out English language classes that varied in length depending on the need and the demand for these services. The other 18 subjects in the study were classified as English-as-a-first-language (EFL) and consisted of students who were native speakers of English and ESL students who were considered English proficient and therefore, no longer needed to attend specialized English language classes.

In order to determine if a particular reading medium; book or computer, was more beneficial or not for a particular language group, subjects were classified into two groups: ESL and EFL. Non-directional *t*-tests for each group were performed using the data from the open-ended comprehension questions (Appendix I). Reading comprehension test scores of third grade ESL students who read children's storybooks published on paper were compared to the reading comprehension test scores of third grade ESL students of the same titles published on multimedia CD-ROM. Table 4.5 presents the results obtained for the ESL group when the data collected were analyzed using a non-directional *t*-test for paired samples.

Table 4.5 Results obtained from a non-directional *t*-test for paired samples, ESL group as measured by open-ended comprehension questions

CD-ROM			Print			<i>df</i>	<i>t</i>	Sig. (2-tailed)
<i>N</i>	Mean	<i>SD</i>	<i>N</i>	Mean	<i>SD</i>			
7	16.11	3.60	7	14.00	3.93	6	1.70	.14

The maximum score on the open-ended comprehension questions (Appendix I) was 24. Table 4.5 indicates that ESL subjects in the CD-ROM group ($N=7$) had a mean score of 16.11 while the ESL subjects in the print group ($N=7$) had a mean score of 14.00. The difference between the CD-ROM group and the print group produced a *t* of 1.70 which is not significant ($p=.14$) and, consequently, indicated no difference between the two ESL groups.

Table 4.6 presents the results obtained for the EFL group when the data collected were analyzed using a non-directional *t*-test for paired samples.

Table 4.6 Results obtained from a non-directional *t*-test for paired samples, English-as-a-first-language group on open-ended comprehension questions

CD-ROM			Print			<i>df</i>	<i>t</i>	Sig. (2-tailed)
<i>N</i>	Mean	<i>SD</i>	<i>N</i>	Mean	<i>SD</i>			
18	17.85	1.95	18	16.54	3.73	17	1.69	.11

Using open-ended comprehension questions (Appendix I) with a maximum score of 24, Table 4.6 indicates that EFL subjects in the CD-ROM group ($N=18$) produced a mean score of 17.85 while EFL subjects in the print group ($N=18$) produced a mean score of 16.54. The difference between the CD-ROM group and the print group produced a *t* of 1.69 which is not significant ($p=.11$) and, consequently, indicated no difference between the two EFL groups.

Reading Level

Based on the Grade Equivalent (GE) scores derived from the scores of the Gates-MacGinitie Reading Test, Canadian Edition, Handscorable Booklet, Level C, Form 1 given at the beginning of the study, the students were classified into three reading levels: reading level 1 which is below grade or $GE \leq 2.9$; reading level 2 which is at grade or $GE = 3.0-3.9$; and reading level 3 which is above grade or $GE \geq 4.0$.

In order to determine how the reading comprehension of third grade students of a particular reading level who read children's storybooks published on paper compared to the reading comprehension of students of the same reading level who read the same titles published on multimedia CD-ROM, a non-directional *t*-test for paired samples for each group, reading level 1, reading level 2 and reading level 3, was used to determine the statistical significance of the difference between the reading comprehension groups as measured by open-ended comprehension questions (Appendix I) for each title. Table 4.7 presents the results obtained for the three reading levels when the data collected were analyzed using a non-directional *t*-test for paired samples for each of the three reading level groups.

Table 4.7 Results obtained from *t*-test for paired samples for each group: reading levels 1, 2 and 3 on open-ended comprehension questions

Reading Level	CD-ROM			Print			<i>df</i>	<i>t</i>	Sig. (2-tailed)
	<i>N</i>	Mean	<i>SD</i>	<i>N</i>	Mean	<i>SD</i>			
1	11	16.14	2.68	11	12.82	3.45	10	3.35	.007
2	7	17.57	2.11	7	16.39	1.10	6	1.36	.222
3	7	19.07	1.89	7	20.00	1.44	6	1.04	.337

The maximum score on the open-ended comprehension test (Appendix I) was 24. As shown in Table 4.7, the analysis for reading level 1 demonstrates that below reading level subjects in the CD-ROM group ($N=11$; mean=16.14) outperformed below reading level subjects in the print group ($N=11$; mean=12.82). The differences between the CD-ROM and print groups produced a t of 3.35 which was statistically significant ($p = .007$). The analysis for reading level 2 indicates that subjects reading at grade level in the CD-ROM group ($N=7$) had a mean score of 17.57 whereas the subjects reading at grade level in the print group ($N=7$) had a mean score of 16.39. The differences between the level 2 reading groups produced a t of 1.36 which was not significant ($p = .222$). The analysis for reading level 3 demonstrates that subjects reading above grade level in the CD-ROM group ($N=7$) had a mean score of 19.07 and subjects reading above grade level in the print group ($N=7$) had a mean score of 20.00. The differences between the two groups reading above grade level produced a t of 1.04 which was not statistically significant ($p = .337$). In summary, the analysis of Table 4.7 on the significance of the reading level of the subjects and their ability to read storybooks on computer CD-ROM compared to their ability to read storybooks on paper as measured by open-ended comprehension questions was that subjects in the computer group reading below grade level performed significantly better than subjects in the traditional book group.

To determine if there were significant differences both between and within the subjects of the three reading level groups reading children's storybooks published on paper and on computer CD-ROM, a one-way analysis of variance (F -test) was used. Table 4.8 presents the results obtained from a one-way analysis of variance (ANOVA) for both between and within the subjects of the three reading levels for both the CD-ROM and print groups.

Table 4.8 ANOVA results for the three reading levels in both the CD-ROM and print groups

		Sum of Squares	<i>df</i>	Mean Square	<i>F</i>	Sig.
Print	Between Groups	223.721	2	111.861	17.785	.000
	Within Groups	138.369	22	6.289		
	Total	362.090	24			
CD-ROM	Between Groups	37.286	2	18.643	3.419	.051
	Within Groups	119.974	22	5.453		
	Total	157.260	24			

As shown in Table 4.8, an analysis of variance between the three reading levels in the control or book group yielded an *F* of 17.785 and demonstrates that there are significant ($p = .000$) differences between the reading levels in the print group. As for the experimental or CD-ROM group, an analysis of variance yielded an *F* of 3.419 and $p = .051$. The analysis of Table 4.8 is based on the results of the open-ended comprehension questions (Appendix I).

Since there were significant differences between the reading levels in the print group, a further post hoc test for multiple comparisons (Bonferroni) was warranted. Table 4.9 presents the results obtained when the three print group reading levels were compared to each other.

Table 4.9 Results obtained from post hoc tests for multiple comparisons (Bonferroni) for print group reading levels 1, 2 and 3 as measured by open-ended comprehension questions

	Reading Levels	Mean Difference	Std. Error	Sig.
Print Group	1 vs. 2	3.57	1.21	.022
	2 vs. 3	3.61	1.34	.040
	1 vs. 3	7.18	1.21	.000

The open-ended comprehension tests (Appendix I) with a maximum score of 24 were used to generate data in Table 4.9. As shown in Tables 4.7 and 4.9, print group reading level 2 (mean=16.39) performed better than print group reading level 1 (mean=12.82). The mean difference between print group reading levels 1 and 2 is 3.57 which is significant ($p = .022$). Print group reading level 3 (mean=20.00) performed better than print group reading level 2 (mean=16.39). The mean difference between print group reading levels 3 and 2 is 3.61 which is significant ($p = .040$). Print group reading level 3 (mean=20.00) performed better than print group reading level 1 (mean=12.81). The mean difference between print group reading levels 3 and 1 is 7.18 which is significant ($p = .000$).

Gender

In order to determine if there was a relationship between the gender of the subjects and the reading comprehension of third grade students who read children's storybooks published on paper and the reading comprehension of students who read the same titles published on multimedia CD-ROM, a non-directional *t*-test for paired samples for each group: gender=male; gender=female, for CD-ROM and print groups as measured by open-ended comprehension questions was performed. Table 4.10 presents the results obtained for each gender in the CD-ROM and print groups when the data collected were analyzed using a non-directional *t*-test for paired samples for each group: gender=male; gender=female.

Table 4.10 The effect on comprehension of gender within treatments

Gender	CD-ROM			Print			<i>df</i>	<i>t</i>	Sig. (2-tailed)
	<i>N</i>	Mean	<i>SD</i>	<i>N</i>	Mean	<i>SD</i>			
Male	12	16.56	2.82	12	14.35	3.10	11	2.6226	.024
Female	13	18.10	2.14	13	17.19	4.15	12	.930	.337

The open-ended comprehension questions (Appendix I) had a maximum score of 24. The analysis for the male group as shown in Table 4.10 indicates that the male CD-ROM group (mean=16.56) performed better than the male print group (mean=14.35). The differences yielded a *t* of 2.6226 which was statistically significant ($p = .024$). The mean score for the female CD-ROM group was 18.10 whereas the mean score for the female print group was 17.19. There was no significant difference ($t = .930, p = .370$) for the females.

To determine if there were significant differences between the reading comprehension results of the two genders for both the CD-ROM and print groups, a one-way analysis of variance (*F*-test) was used. Table 4.11 presents the results obtained from a one-way analysis of variance that compared results between male and female subject groups for both the CD-ROM and print groups.

Table 4.11 The effect on comprehension of gender across treatments

		Sum of Squares	<i>df</i>	Mean Square	<i>F</i>	Sig.
Print	Between Groups	50.263	1	50.263	3.707	.067
	Within Groups	311.827	23	13.558		
	Total	362.090	24			
CD-ROM	Between Groups	14.677	1	14.677	2.368	.138
	Within Groups	142.583	23	6.199		
	Total	157.260	24			

As shown in Tables 4.10 and 4.11, an analysis of the data demonstrated that for the print group, the female group had a mean score of 17.19 whereas the male group had a mean score of 14.35. There was no significant difference ($F = 3.707, p = .067$) between the genders in the print group. As for the CD-ROM group, the female group had a mean score of 18.10 while the male group had a mean of 16.56. There was no significant difference ($F = 2.368, p = .138$) between the genders in the CD-ROM group. These results are based on the subjects' performance on the open-ended comprehension tests (Appendix I) and had a maximum score of 24.

Computer Ownership

In order to determine if there was a relationship between students having a computer at home or not and the reading comprehension of third grade students who read children's storybooks published on paper and the reading comprehension of students who read the same titles published on multimedia CD-ROM, a non-directional *t*-test for each group; students who have a computer at home and students who do not have a computer at home was performed. Table 4.12 presents the results obtained for subjects who have a computer at home and for subjects who do not have a computer at home in the CD-ROM and print groups when the data collected were analyzed using a non-directional *t*-test.

Table 4.12 The effect on comprehension of computer ownership within treatments

Computer	CD-ROM			Print			<i>df</i>	<i>t</i>	Sig. (2-tailed)
	<i>N</i>	Mean	<i>SD</i>	<i>N</i>	Mean	<i>SD</i>			
Has a Computer at Home	13	17.71	3.03	13	15.96	4.49	12	1.810	.095
Does Not Have a Computer at Home	12	16.98	2.00	12	15.69	3.30	11	1.454	.174

The open-ended comprehension questions (Appendix I) have a maximum score of 24. The analysis for computer ownership as shown in Table 4.12 indicates that the CD-ROM group had a mean score of 17.71 and the print group had a mean score of 15.96. There were no significant differences for computer ownership ($t = 1.810, p = .095$) between the CD-ROM and print groups. As for students who do not own a computer at

home, the analysis indicated that the CD-ROM group had a mean score of 16.98 whereas the print group had a mean score of 15.69. There were no significant differences ($t=1.454, p=.174$) between the CD-ROM and print groups for students who do not own a computer.

To determine if there was a significant relationship between the reading comprehension test results of the print groups; computer at home versus no computer at home and the reading comprehension test results of the CD-ROM groups; computer at home versus no computer at home, a one-way analysis of variance (F -test) was used. Table 4.13 presents the results obtained from a one-way analysis of variance that compares reading comprehension results between the print computer ownership or not group and the CD-ROM computer ownership or not group. Results were based on the open-ended comprehension tests (Appendix I) and had a maximum score of 24.

Table 4.13 The effect on comprehension of computer ownership across treatments

		Sum of Squares	<i>df</i>	Mean Square	<i>F</i>	Sig.
Print	Between Groups	.469	1	.469	.030	.864
	Within Groups	361.621	23	15.723		
	Total	362.090	24			
CD-ROM	Between Groups	3.347	1	3.347	.500	.487
	Within Groups	153.913	23	6.692		
	Total	157.260	24			

As shown in Tables 4.12 and 4.13, an analysis of the data demonstrated that for the print group, subjects having a computer at home ($N=13$) had a mean score of 15.96 whereas subjects not having a computer at home ($N=12$) had a mean score of 15.69. The analysis of the data indicated no significant difference ($F = .030, p = .864$) between owning a computer or not in the print group. As for the CD-ROM group, subjects owning a computer at home ($N=13$) had a mean score of 17.71 whereas subjects not owning a computer at home ($N=12$) had a mean score of 16.98. There were no significant differences ($F=.500, p =.487$) between owning a computer at home or not in the CD-ROM group. These results were based on the subjects' performance on the open-ended comprehension tests (Appendix I) and had a maximum score of 24.

Books Borrowed from a Library

In order to determine if there was a relationship between those students who had books borrowed from a library at the time of the study and the reading comprehension of third grade students who read children's storybooks published on paper and the reading comprehension of students who read the same titles published on multimedia CD-ROM, a non-directional t -test for paired samples for each group: students who had books borrowed from a library and students who did not have books borrowed from a library, for CD-ROM and print groups as measured by open-ended comprehension questions was performed. Table 4.14 presents the results obtained for each group, students having books borrowed from a library or not in the CD-ROM and print groups when the data collected were analyzed using a non-directional t -test for paired samples for the CD-ROM and print groups.

Table 4.14 The effect on comprehension of books borrowed from a library within treatments

	CD-ROM			Print			Sig.		
	<i>N</i>	Mean	<i>SD</i>	<i>N</i>	Mean	<i>SD</i>	<i>df</i>	<i>t</i>	(2-tailed)
Has Borrowed Books	10	17.88	2.55	10	15.73	3.74	9	2.186	.057
Does Not Have Borrowed Books	15	17.02	2.60	15	15.90	4.11	14	1.288	.218

The open-ended comprehension tests (Appendix I) had a maximum score of 24. As shown in Table 4.14, the analysis for students who had books borrowed from a library indicates that the CD-ROM group had a mean score of 17.88 whereas the print group had a mean score of 15.73. There were no significant differences ($t=2.186, p=.057$) between subjects having books borrowed from a library in the CD-ROM and print groups. As for students who did not have books borrowed from a library, the analysis indicated that the CD-ROM group had a mean score of 17.02 while the print group had a mean score of 15.90. There were no significant differences ($t=1.288, p=.218$) between the two groups not having books borrowed from a library.

To determine if there were significant differences between the print groups; students with borrowed library books versus students without borrowed library books and between the CD-ROM groups; students with borrowed library books versus students without borrowed library books, a one-way analysis of variance (F - test) was used. Table 4.15 presents the results obtained from a one-way analysis of variance that compares reading comprehension results between the print groups; books borrowed from a library or not and the CD-ROM groups; books borrowed from a library or not. Results

are based on the open-ended comprehension tests (Appendix I) and have a maximum score of 24.

Table 4.15 The effect on comprehension of books borrowed from a library across treatments

		Sum of Squares	df	Mean Square	F	Sig.
Print	Between Groups	.184	1	.184	.012	.915
	Within Groups	361.906	23	15.735		
	Total	362.090	24			
CD-ROM	Between Groups	4.420	1	4.420	.665	.423
	Within Groups	152.840	23	6.645		
	Total	157.260	24			

As shown in Tables 4.14 and 4.15, an analysis of the data demonstrated that for the control or book group, subjects not having books borrowed from a library ($N=15$) had a mean score of 15.90 whereas subjects having books borrowed from a library ($N=10$) had a mean score of 15.73. The analysis of the data indicated no significant difference ($F = .012, p = .915$) for subjects with books borrowed from a library or not in the print group. As for the CD-ROM group, subjects having books borrowed from a library ($N=10$) had a mean score of 17.88 whereas subjects not having borrowed books from a library ($N=15$) had a mean score of 17.02. The analysis for the CD-ROM group indicated no significant differences ($F = .665, p = .423$) between having books borrowed from a library or not in the CD-ROM group. These results were based on the subjects'

performance on the open-ended comprehension tests (Appendix I) and had a maximum score of 24.

Question Classification According to Pearson and Johnson's Taxonomy

The 12 open-ended comprehension questions (Appendix I) for each storybook title in the study can be further classified according to Pearson and Johnson's question-answer relationship taxonomy (1978) into textually explicit questions, which require factual recall of information with the answers located directly in the text; textually implicit questions, or questions in which the answers are located in the text but may be in several locations and require processing or inference to assemble the answer; and scriptually implicit questions or questions which require the use of prior knowledge as well as information in the text to answer. For each title, there were 4 textually explicit questions, 4 textually implicit questions and 4 scriptually implicit questions. The Question-Answer Analysis Classification Sheet (Appendix II) was used to calculate scores for each of the three categories. In order to determine if there was a relationship between the kinds of questions students were asked and whether or not a particular kind of question according to Pearson and Johnson's question-answer relationship taxonomy (1978) elicited statistically significantly different test scores for the CD-ROM groups as compared to the print groups, a non-directional *t*-test for paired samples was used. Textually explicit question and answers from the print group were paired with the same textually explicit questions and answers from the CD-ROM group; textually implicit questions and answers from the print group were paired with the same textually implicit questions answers from the CD-ROM group; and scriptually implicit question and answers from the print group were paired with the same scriptually implicit questions and answers from the CD-ROM group. A *p* value of $\leq .05$ was used as the standard for establishing statistical significance. Table 4.16 presents the results obtained from the

non-directional *t*-test for paired samples using print group textually explicit questions paired with CD-ROM group textually explicit questions; print group textually implicit questions paired with CD-ROM group textually implicit questions; and print group scriptually implicit questions paired with CD-ROM group scriptually implicit questions.

Table 4.16 Results obtained from a non-directional *t*-test for paired samples print group-CD-ROM groups according to Pearson and Johnson's (1978) question-answer categories: textually explicit, textually implicit and scriptually implicit

Pair Group	CD-ROM			Print			<i>df</i>	<i>t</i>	Sig. (2-tailed)
	<i>N</i>	Mean	<i>SD</i>	<i>N</i>	Mean	<i>SD</i>			
Textually Explicit	25	12.96	2.38	25	11.56	3.40	24	2.18	.039
Textually Implicit	25	9.92	1.86	25	9.40	2.97	24	.95	.349
Scriptually Implicit	25	11.84	2.50	25	10.70	2.57	24	2.07	.050

The maximum score on the open-ended comprehension test (Appendix I) is 24. As shown in Table 4.16, the analysis for the Textually Explicit paired samples indicated that the CD-ROM group (mean=12.96) performed better than the print group (mean=11.56). The analysis yielded a *t* of 2.18 which was statistically significant (.039) and consequently, indicated that for open-ended textually explicit comprehension questions, a statistically significant difference was detected between the CD-ROM group and the print group. The analysis for the Textually Implicit paired samples demonstrated that the CD-ROM group had a mean score of 9.92 while the print group had a mean score of 9.40. There were no significant differences (*t* =.95, *p*=.349) between the Textually

Implicit paired samples. The analysis for the Scriptually Implicit paired samples indicates that the CD-ROM group (mean=11.84) outperformed the print group (mean=10.70). The difference between the Scriptually Implicit paired samples yielded a t of 2.07 which was statistically significant ($p=.050$) and consequently, indicated that for open-ended scriptually implicit reading comprehension questions, a statistically significant difference was detected between the CD-ROM and print groups.

CHAPTER V.

SUMMARY AND DISCUSSION

The purpose of this study was to compare the reading comprehension of third grade students who read children's storybooks published on paper to the reading comprehension of a second group of third grade students reading the same titles published on multimedia CD-ROM. This study also compared the reading attitude of students prior to reading CD-ROM interactive storybooks to the reading attitude of the same students after reading CD-ROM interactive storybooks. In addition, the reading comprehension test scores were organized into various subgroups and analyzed so that the effects of CD-ROM storybooks on third grade students are known. The various subgroups were language (English-as-a-second-language or English-as-a-first-language); reading level (below grade, at grade or above grade); gender (male or female); ownership of a computer at home (yes or no); and whether the subjects had books borrowed from a library at the time of the study. The questions used in the study were classified according to Pearson and Johnson's question-answer relationship taxonomy (1978).

Summary of the Problem, Methodology, and Results

Three of the four children's CD-ROM storybooks chosen for this study are produced by Discis Books, a company that has won awards such as the National Parenting Center's Seal of Approval (1991), and the California Children's Media Award (1992). With over a million copies of their product sold in thirty-five countries throughout the world as well as being adopted as official textbooks in Alabama, New Mexico, Oklahoma, Utah and Ontario (Harmony Interactive Inc., 1996), little is published on the effects of interactive children's storybooks read on a computer. Current

educational practice both in the school and home, serves as a catalyst for research in improving educational methods and practices (Kamil, 1984). This study was an attempt to investigate the effects, primarily reading comprehension and attitude, of interactive CD-ROM storybooks on third grade students.

The subjects chosen to participate in the study were the third grade students from the English stream of a large suburban dual track (English and French Immersion) elementary school who returned the signed parental permission forms. Of the 35 potential candidates, 28 agreed to participate and 25 completed the study. The subjects were placed in matched pairs according to gender and performance on a reading comprehension test (Gates-MacGinitie Reading Test, Canadian Edition, Handscorable Booklet, Level C, Form 1) given at the beginning of the study. One member from each matched pair was randomly assigned to either group A or group B so that each group had an equal number of boys and girls.

The four CD-ROM software titles used in the study were chosen for their suitability in both reading level and interest to third graders. Each interactive storybook has a corresponding print version with identical text and illustrations. One at a time, each student was taken out of the classroom and read a short work of fiction and then answered 12 open-ended comprehension questions in writing. Each student read a total of two storybook titles in print and two storybooks titles on CD-ROM over the four week study period. The open-ended comprehension questions (Appendix I) were based on Pearson and Johnson's question and answer relationship taxonomy (1978) and consisted of four textually explicit questions, four textually implicit questions and four scriptually implicit questions for each storybook title. To improve the internal validity of the study, the control and treatment group were switched to the effect that each subject in the study served as a control subject for two storybook titles and as a treatment subject for the other two storybook titles (See Figure 3.1). The computer provided student controlled

word and sentence pronunciation, simultaneous highlighting of text with audio narration and vocabulary help for the CD-ROM groups whereas the researcher provided, when requested by a student, vocabulary and pronunciation support for the print groups. Prior to exposure to interactive CD-ROMs, students completed McKenna and Kear's (1991) Elementary Reading Attitude Survey (Appendix III). Upon completion of the second CD-ROM storybook title, the students completed the same reading attitude survey.

The reading comprehension test results from the four CD-ROM titles were compared to the reading comprehension test results from the four print titles. The pre/posttest results of the Elementary Reading Attitude Survey were compared. The results of the reading comprehension tests were organized into subgroups and analyzed. The results of the open-ended comprehension tests as shown in Table 4.1 indicated that subjects in the group that read storybooks on CD-ROM performed significantly better than subjects in the group that read the storybooks in print form. The results of the Elementary Reading Attitude Survey as shown in Table 4.4 indicated that there wasn't a significant difference in the posttest reading attitude over the pretest reading attitude. The results of the subgroup organizations using the open-ended comprehension questions indicated the following:

Language Group

- There was no significant difference between the ESL subjects in the CD-ROM group compared to ESL subjects in the print group (Table 4.5).
- There was no significant difference between the EFL subjects in the CD-ROM group compared to EFL subjects in the print group (Table 4.6).

Reading Level

- Subjects reading below grade level in the CD-ROM group performed significantly better than subjects reading below grade level in the print group (Table 4.7).
- There was no significant difference between subjects reading at grade level in the CD-ROM group compared to subjects reading at grade level in the print group (Table 4.7).
- There was no significant difference between subjects reading above grade level in the CD-ROM group compared to subjects reading above grade level in the print group (Table 4.7).
- There was no significant difference across the three reading level groups (below grade level, at grade level and above grade level) for subjects in the CD-ROM group (Table 4.8).
- Subjects in the at grade level print group performed significantly better than subjects in the below grade level print group (Table 4.9).
- Subjects in the above grade level print group performed significantly better than subjects in the at grade level print group (Table 4.9).

Gender

- Male subjects in the CD-ROM group performed significantly better than male subjects in the print group (Table 4.10).
- There was no significant difference between the female subjects in the CD-ROM group compared to the female subjects in the print group (Table 4.10).

- There was no significant difference between the female subjects in the CD-ROM group compared to the male subjects in the CD-ROM group (Table 4.11).
- There was no significant difference between the female subjects in the print group compared to the male subjects in the print group (Table 4.11).

Computer Ownership

- There was no significant difference between subjects owning a computer at home in the CD-ROM group and subjects owning a computer at home in the print group (Table 4.12).
- There was no significant difference between subjects not owning a computer at home in the CD-ROM group and subjects not owning a computer at home in the print group (Table 4.12).

Books Borrowed From a Library

- There was no significant difference between subjects having books borrowed from a library in the CD-ROM group and subjects having books borrowed from a library in the print group (Table 4.14).
- There was no significant difference between subjects not having books borrowed from a library in the CD-ROM group and subjects not having books borrowed from a library in the print group (Table 4.14).

Question Classification According to Pearson and Johnson's Taxonomy

- Subjects answering textually explicit questions in the CD-ROM group performed significantly better than subjects answering textually explicit questions in the print group (Table 4.16).

- There was no significant difference between subjects answering textually implicit questions in the CD-ROM group compared to subjects answering textually implicit questions in the print group (Table 4.16).
- Subjects answering scriptually implicit questions in the CD-ROM group performed significantly better than subjects answering scriptually implicit questions in the print group (Table 4.16).

Interpretation of the Findings on Reading Comprehension

The findings indicate that in using open-ended comprehension questions, third grade subjects in the group that read storybooks on CD-ROM performed significantly better than third grade subjects in the group that read the storybooks in print form (Table 4.1) and thus the null hypothesis, that there was no significant difference between the reading comprehension of third grade students reading storybook titles on CD-ROM and the reading comprehension of third grade students reading storybooks on print, was rejected. The findings of this study, which compared students using computer displayed text with audio and glossary support to print versions of the same texts, are consistent with previous research investigating the effects of computer mediated text with support (Greenlee-Moore & Smith, 1996; Large et al., 1994; Matthew, 1996; Reinking & Rickman, 1990; Reinking & Schreiner, 1985). Interestingly enough, although Matthew (1996) did not find significant differences between CD-ROM and print groups using open-ended comprehension questions similar to ones used in this study, Matthew did find that the CD-ROM group performed significantly better than the print group as measured by story retellings. In order to explain the discrepancy in open-ended comprehension test results between the Matthew study (1996) and the current research, two explanations are offered for consideration. In the Matthew study (1996), only one of the three CD-ROM titles used in the study offered student-controlled audio glossary and pronunciation

support whereas in the current study, three of the four CD-ROM titles offered student-controlled audio glossary and pronunciation support. Computer treatments offering audio pronunciation and glossary support fared better in comprehension tests (Gretes & Green, 1994; Reinking & Rickman, 1990; Reinking & Schreiner, 1985; Stine, 1993). Secondly, in the Matthew study (1996), there were ten open-ended comprehension questions per storybook title of which two questions were classified according to Pearson and Johnson's question-answer relationship taxonomy (1978) as being Scriptually Implicit whereas in the current study, there were twelve open-ended comprehension questions per storybook title of which four were classified according to Pearson and Johnson's taxonomy (1978) as being Scriptually Implicit. According to Table 4.16, subjects answering Scriptually Implicit questions in the CD-ROM group performed significantly better than subjects answering Scriptually Implicit questions in the print group.

As shown in Table 4.7, subjects reading below grade level in the CD-ROM group performed better than subjects reading below grade level in the print group. This finding is consistent with previous work involving students with reading difficulties, Chapter 1 students and low literate adults and investigating the effects of CD-ROM text with audio and glossary support (Gretes & Green, 1994; Hastings, 1997; Lewin, 1997a; Lewin, 1997b; Montali & Lewandowski, 1996; Reinking & Schreiner, 1985; Stine, 1993). The finding of no difference between CD-ROM and print groups for subjects reading at or above grade level (Table 4.7) is consistent with the previous research of Greenlee-Moore & Smith (1996) in that there was no difference between the computer text and print groups when reading shorter and easier narratives. Greenlee-Moore & Smith's (1996) study in which the computer text group fared better when using longer and more difficult narratives is consistent with the current study in which subjects in the below grade reading level CD-ROM group performed better than subjects in the below grade

reading level print group reading narratives suitable for the third grade reading level (Table 4.7).

The finding of no significant difference between the ESL subjects in the CD-ROM group compared to ESL subjects in the print group as indicated in Table 4.5 are inconsistent with the findings of past research involving the use of CD-ROM with audio narration and vocabulary support. Previous work demonstrated that in a foreign language class, CD-ROMs proved to have positive and beneficial effects (Aweiss, 1994; Brett, 1997; Jakobsdottir & Hooper, 1995). This difference in results may be due in part to the fact that there was no formal method of classifying students as being ESL and needy of supplementary English language classes employed in the school district. A number of factors including the ESL teacher work load, number of requests for ESL instruction and informal interviews with the student and classroom teacher were considered. It is possible that the age difference of the participants may have also been a contributing factor. In both the Aweiss (1994) and Brett (1997) studies, the participants were college undergrads and in the Jakobsdottir & Hooper (1995) study, the participants were fifth graders whereas in the current study, the participants were third graders. The overall effects of CD-ROM on reading comprehension as shown in Table 4.1 are positive. This finding is consistent with Kulik and Kulik's (1991) meta-analysis of all computer-based instruction from 1966-1986.

Interpretation of the Findings on Reading Attitude

The findings indicate that there was no significant difference in students' attitude after exposure to storybooks on CD-ROM as measured by the Elementary Reading Attitude Survey (Table 4.4) and thus the null hypothesis, there is no difference between the posttest reading attitude of third grade students who read storybooks on CD-ROM and the pretest reading attitude of third grade students who have not read children's

storybooks on CD-ROM, was accepted. These findings are consistent with Matthew (1996) who used the same Elementary Reading Attitude Survey. Conversely, Stine (1993) noted higher academic reading attitudes for the CD-ROM group whereas no change in the recreational reading attitude was noted for either the CD-ROM or control groups. Similar results which indicate no change in recreational reading attitude were found in the current study and are consistent with Stine (1993). Stine (1993) also used the Elementary Reading Attitude Survey (Appendix III). To explain the discrepancy between the higher academic reading attitudes noted by Stine (1993) and the current study, it is noteworthy to mention that in the Stine (1993) study, the treatment group consisted of second grade Chapter 1 students receiving whole language instruction supplemented with CD-ROM books taught by the researcher whereas the control group consisted of second grade Chapter 1 students receiving whole language instruction taught by an assistant. The discrepancy may be due to the difference in instructors between the control and treatment groups and/or to the additional time engaged in reading the CD-ROM books given to the treatment group. The current study's finding of no change in recreational and academic reading attitudes is consistent with Adam and Wild's (1997) finding of no difference in general reading attitude after exposure to CD-ROM storybooks. However, further analysis by Adam and Wild (1997) of the treatment group into reluctant and willing reading groups revealed that reluctant readers developed a significant and favourable attitude change towards reading CD-ROM storybooks. In addition to a Likert-type questionnaire, Adam and Wild (1997) employed interviews and unstructured observations to collect data. The discrepancy in findings may be due to a 'ceiling effect' exhibited on the test results of the current study and/or the use of different measuring instruments. Previous research using qualitative methods with videotape and researcher observations which note favourable attitudes towards CD-ROM (Adam & Wild, 1997; Greenlee-Moore & Smith, 1996; Lamy, 1990; Nikkel, 1995) are not

comparable with the findings of the current study since qualitative methods of recording data were not employed in the current study.

Limitations of the Study

The main limitations for the study were the length of treatment, the number of ESL students and the method for determining ESL classification.

The continuing cooperation of the classroom teachers was a consideration for the study duration as the researcher did not want to burden the classroom teachers for more than one month with the continual disruption of having students enter and leave the classroom.

The number of ESL students receiving pull-out English language instruction was seven and the informal method for determining the need for pull-out English language instruction was inconsistent from year to year and from school to school which limits the possibility for comparison. Results from the reading comprehension test (Gates-MacGinitie Reading Test, Canadian Edition, Handscorable Booklet, Level C, Form 1) given at the beginning of the study to establish the matched pairs indicated that the English-as-a-second-language students demonstrated reading abilities below grade level, at grade level and above grade level.

The inability to make direct comparisons with the current research employing quantitative data collection methods and previous research employing qualitative data collection methods may be considered a limitation. It is difficult to compare and contrast the research findings of previous qualitative research using CD-ROM storybooks and describing students' reactions while reading CD-ROM books and the current study which includes only quantitative data collection methods such as reading comprehension tests and reading attitude surveys (Lamy, 1990; Nikkel, 1995).

Suggestions for Further Research

Given that this study indicates that CD-ROM storybooks do have value in the reading component of third grade classes, further research studying its effects over a longer period of time and using more storybook titles is warranted.

Another potential research suggestion would be to study the effects of CD-ROM storybooks on a larger number of ESL students.

Surprisingly, in the current study, boys reading CD-ROM storybooks performed significantly better than boys reading print books. Another research suggestion would be to study the subject-computer interaction for boys and compare it to the subject-computer interaction for girls to determine which CD-ROM characteristics boys use to their advantage to aid comprehension.

Implications

One of the objectives in education today is to experience literacy in a variety of formats and contexts (Polin, 1990). Having CD-ROM storybooks in a classroom or school library provides students with the opportunity to experience literature in another format. The CD-ROM storybook offers a captivating, risk-free environment (Glasgow, 1996).

Previous research demonstrates that students reading material that is considered above their reading ability perform better in hypertext situations than in print, and that students of below grade reading ability perform better on CD-ROM than in print (Greenlee-Moore & Smith, 1996; Reinking & Schreiner, 1985). This last point is confirmed by the present study. This suggests that the CD-ROM hypertext medium may be particularly suitable for presenting information that is difficult to understand for a particular audience and that is above the reading ability of the reader.

In this study, boys reading storybooks on CD-ROM performed better than boys reading storybooks in print while girls performed equally well on CD-ROM and on print and as well as boys do on CD-ROM. This suggests that the CD-ROM format may be an appropriate format for boys to experience success in reading and possibly encourage boys to read. Likewise for readers with a low reading level, the CD-ROM format may be a useful tool to assist comprehension and motivate learners.

Overall, students reading storybooks on CD-ROM performed better than students reading storybooks in print. Reading comprehension test scores for the print group produced lower scores overall with significant differences between the strong, weak and average readers whereas the reading comprehension test scores from the CD-ROM group produced significant differences only between the stronger and weaker readers, and not between the stronger and average or average and weaker readers. This suggests that CD-ROMs with audio and glossary support are a more efficient medium of transmitting information.

This study suggests that having literature in the form of CD-ROM storybooks with a computer available in a grade three classroom is a valuable and educationally sound practice that promotes literacy.

Conclusions

Children's interactive storybooks on CD-ROM such as the ones used in this study are a valuable literary format. With student controlled audio and glossary support and highlighted text accompanied by narration, students can read a story on the computer screen and follow along while the text is highlighted and read aloud. Students can click on a word to hear the word pronounced again or hear its glossary definition. Students reading a CD-ROM book can go back and read favourite sections of a story or skip ahead. The CD-ROM books contain the same colourful illustrations as their print

counterparts. With storybooks on CD-ROM, students understand more by answering open-ended comprehension questions than by reading storybooks in print. This study has shown that children's interactive storybooks on CD-ROM are a valuable literary format that can assist reading comprehension in the third grade classroom.

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APPENDIX I
OPEN-ENDED QUESTIONS

*To accommodate the thesis format, the questionnaires were reformatted on letter size paper. Versions used in the study were printed with a larger font (Times 14), double-spaced, and printed on legal size paper.

Name _____

The Tale of Benjamin Bunny

Directions: Answer each question as well as you can. If you need more space, use the back of this paper.

1. How did Mrs. Bunny earn a living?

2. Why was Peter dressed in a red cotton handkerchief?

3. Why did Peter decide to go for a walk?

4. Why did Peter and Benjamin Bunny go to Mr. McGregor's garden?

5. Why did Benjamin Bunny think that the McGregors were gone for the day?

6. How did Peter and Benjamin Bunny plan to use the red handkerchief?

7. Where did Peter and Benjamin Bunny hide in the garden ?

8. While in the garden, why did Peter not eat anything and want to go home?

9. Why did Peter and Benjamin Bunny hide in the garden?

10. Why do you think the mice winked at Peter and Benjamin Bunny?

11. Who do you think was more afraid in the garden, Peter or Benjamin Bunny and why do you think so?

12. How did Mr. Bunny show he was angry with Benjamin Bunny?

*To accommodate the thesis format, the questionnaires were reformatted on letter size paper. Versions used in the study were printed with a larger font (Times 14), double-spaced, and printed on legal size paper.

Name _____

Northern Lights: The Soccer Trails

Directions: Answer each question as well as you can. If you need more space, use the back of this paper.

1. Why was Kataujaq given that name?

2. How does Kataujaq kiss?

3. Describe what it is like to travel on sea ice on a sled ?

4. What kinds of things did Kataujaq like to do during the summer?

5. Why did Kataujaq collect flowers and rocks?

6. What is Kataujaq's favourite time of the year and why do you think so?

7. What happened to Kataujaq's mother?

8. Why did Kataujaq cry at night ?

9. In this story, what happens to people when they die?

10. Why does Kataujaq's grandmother like to come out at night and watch the people play soccer?

11. Why wasn't Kataujaq lonely anymore?

12. Why did Kataujaq's grandmother tell her the story about the northern lights?

*To accommodate the thesis format, the questionnaires were reformatted on letter size paper. Versions used in the study were printed with a larger font (Times 14), double-spaced, and printed on legal size paper.

Name _____

Strega Nona Meets Her Match

Directions: Answer each question as well as you can. If you need more space, use the back of this paper.

1. Why did Strega Nona ask Big Anthony and Bambolona to sweep and polish?

2. Why did Strega Amelia decide to move to the little town in Calabria?

3. Why did the townspeople stop going to visit Strega Nona?

4. Why wasn't Strega Nona able to pay Bambolona and Big Anthony anymore?

5. What kind of work did Big Anthony do for Strega Amelia?

6. Why did Strega Amelia leave Big Anthony in charge for a few days?

7. What happened when Strega Amelia left Big Anthony in charge while she was away?

8. Why did the townspeople return to Strega Nona ?

9. What did the mayor tell Strega Amelia when she came back from her visit?

10. Why was Strega Nona happy at the end of the story?

11. What happened when the mayor went to see Big Anthony at Strega Amelia's place?

12. List three things that Strega Amelia and Strega Nona try to do for the townspeople.

****To accommodate the thesis format, the questionnaires were reformatted on letter size paper. Versions used in the study were printed with a larger font (Times 14), double-spaced, and printed on legal size paper.**

Name _____ Thomas' Snowsuit

Directions: Answer each question as well as you can. If you need more space, use the back of this paper.

1. ***What does Thomas think of his snowsuit?**

2. ***What did Thomas' mother do when he said he would not put on his snowsuit?**

3. ***What happened to Thomas' living room?**

4. **How did the teacher and the principal feel when they discovered they were wearing each other's clothes?**

5. ***How did the teacher fit in Thomas' snowsuit?**

6. ***What happened when the principal tried to put Thomas in his snowsuit?**

7. ***What happens when Thomas has to put on his snowsuit?**

8. ***What does Thomas say when he has to put on his snowsuit?**

9. ***In this story how do people get put into their clothes?**

10. ***Why did Thomas finally put on his snowsuit at recess?**

11. **Why did Thomas not want to go outside at recess?**

12. **How did the principal and the teacher get back into their own clothes?**

*(Matthew, 1995).

APPENDIX II
QUESTION-ANSWER ANALYSIS CLASSIFICATION SHEETS

Name _____

Open Ended Questions Analysis for The Tale of Benjamin Bunny

Directions for scoring:

Correct answer = 2 points

Partially correct answer = 1 point

Incorrect or No Answer = 0 point

Text
Explicit

Text
Implicit

Script
Implicit

1. _____

2. _____

3. _____

4. _____

5. _____

6. _____

7. _____

8. _____

9. _____

10. _____

11. _____

12. _____

TOTALS _____ + _____ + _____ = _____

Name _____

Open Ended Questions Analysis for Northern Lights: The Soccer Trails

Directions for scoring:

Correct answer = 2 points

Partially correct answer = 1 point

Incorrect or No Answer = 0 point

Text
Explicit

Text
Implicit

Script
Implicit

1. _____

2. _____

3. _____

4. _____

5. _____

6. _____

7. _____

8. _____

9. _____

10. _____

11. _____

12. _____

TOTALS _____ + _____ + _____ = _____

Name _____

Open Ended Questions Analysis for Strega Nona Meets Her Match

Directions for scoring:

Correct answer = 2 points

Partially correct answer = 1 point

Incorrect or No Answer = 0 point

Text
Explicit

Text
Implicit

Script
Implicit

1. _____

2. _____

3. _____

4. _____

5. _____

6. _____

7. _____

8. _____

9. _____

10. _____

11. _____

12. _____

TOTALS _____ + _____ + _____ = _____

Name _____

Open Ended Questions Analysis for Thomas' Snowsuit

Directions for scoring:

Correct answer = 2 points

Partially correct answer = 1 point

Incorrect or No Answer = 0 point

Text
Explicit

Text
Implicit

Script
Implicit

1. _____

2. _____

3. _____

4. _____

5. _____

6. _____

7. _____

8. _____

9. _____

10. _____

11. _____

12. _____

TOTALS _____ + _____ + _____ = _____

APPENDIX III
ELEMENTARY READING ATTITUDE SURVEY

ELEMENTARY READING ATTITUDE SURVEY

School _____ Grade _____ Name _____

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1. How do you feel when you read a book on a rainy Saturday?



JIM DAVIS

2. How do you feel when you read a book in school during free time?



3. How do you feel about reading for fun at home?

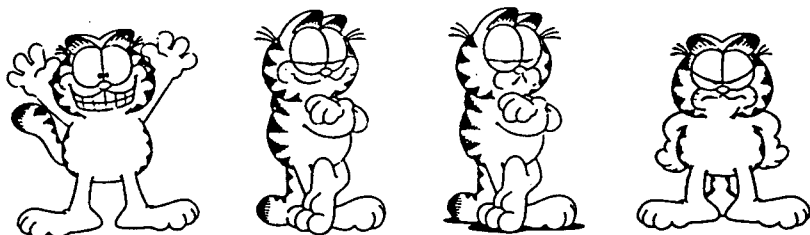


4. How do you feel about getting a book for a present?

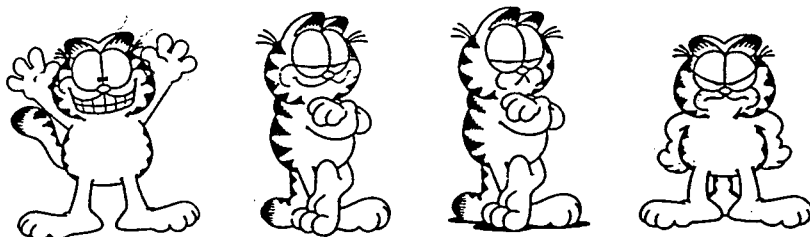


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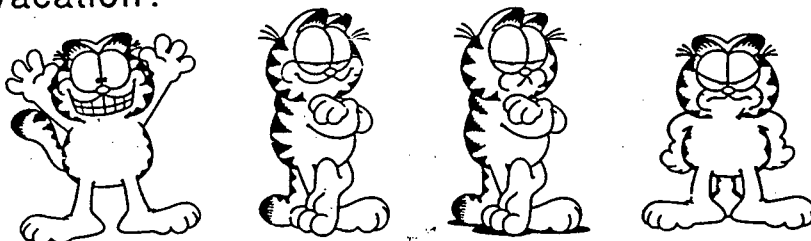
5. How do you feel about spending free time reading?



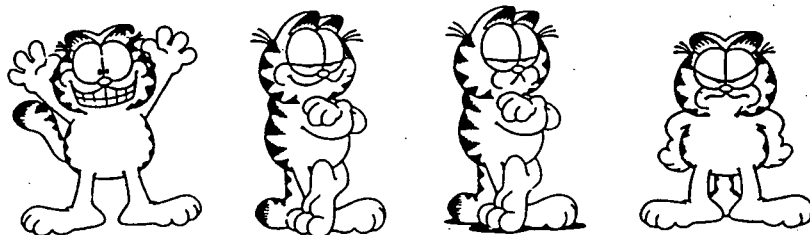
6. How do you feel about starting a new book?



7. How do you feel about reading during summer vacation?



8. How do you feel about reading instead of playing?



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9. How do you feel about going to a bookstore?



10. How do you feel about reading different kinds of books?



11. How do you feel when the teacher asks you questions about what you read?

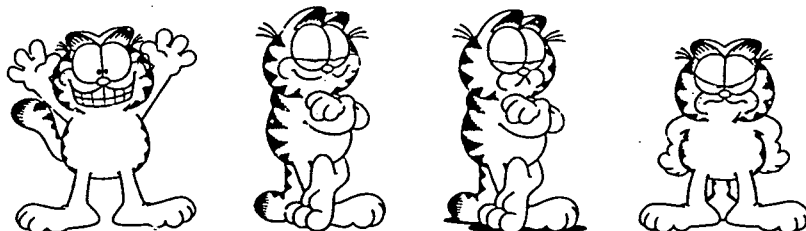


12. How do you feel about doing reading workbook pages and worksheets?

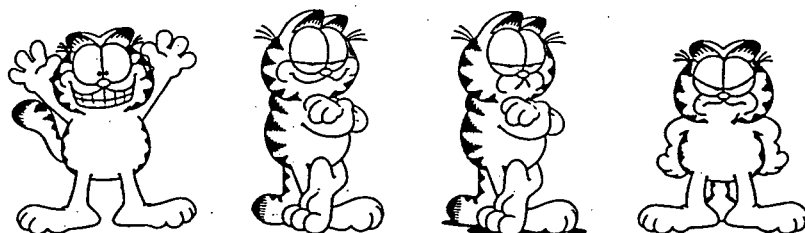


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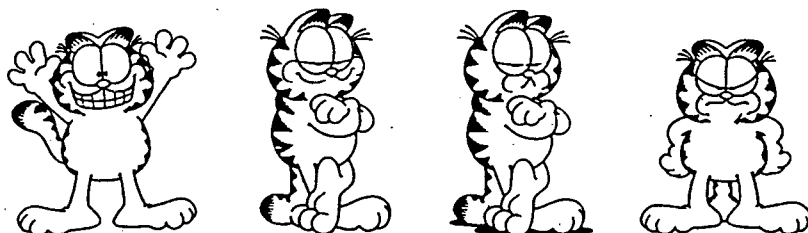
13. How do you feel about reading in school?



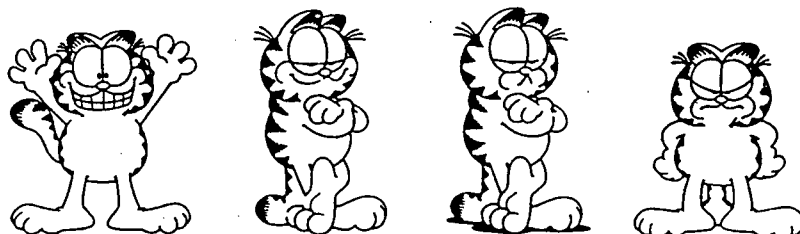
14. How do you feel about reading your school books?



15. How do you feel about learning from a book?

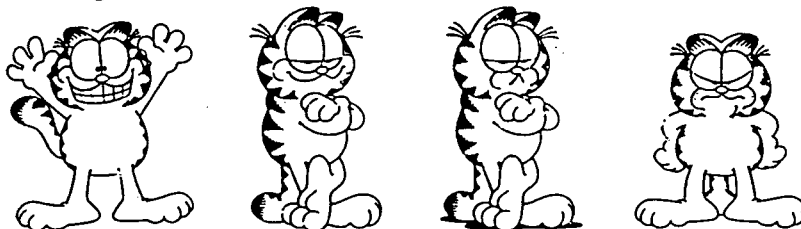


16. How do you feel when it's time for reading class?

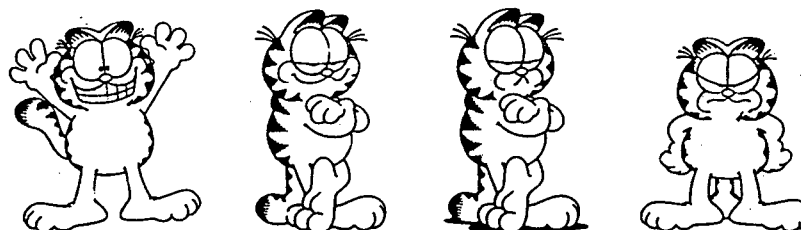


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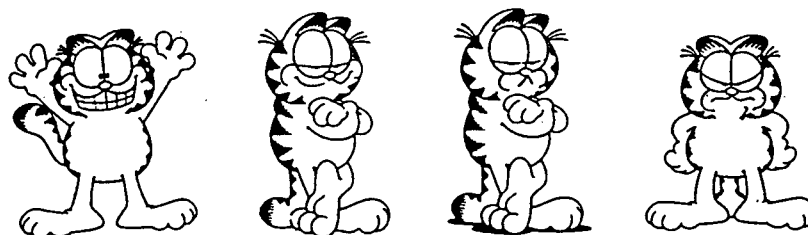
17. How do you feel about the stories you read in reading class?



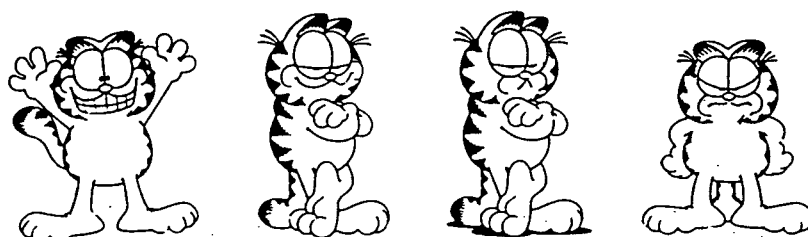
18. How do you feel when you read out loud in class?



19. How do you feel about using a dictionary?



20. How do you feel about taking a reading test?



Elementary Reading Attitude Survey Scoring sheet

Student name _____

Teacher _____

Grade _____ Administration date _____

Scoring guide

- | | |
|----------|---------------------------|
| 4 points | Happiest Garfield |
| 3 points | Slightly smiling Garfield |
| 2 points | Mildly upset Garfield |
| 1 point | Very upset Garfield |

Recreational reading

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____
10. _____

Raw score: _____

Academic reading

11. _____
12. _____
13. _____
14. _____
15. _____
16. _____
17. _____
18. _____
19. _____
20. _____

Raw score: _____

Full scale raw score (Recreational + Academic): _____

Percentile ranks

Recreational

Academic

Full scale

Elementary Reading Attitude Survey

Directions for use

The Elementary Reading Attitude Survey provides a quick indication of student attitudes toward reading. It consists of 20 items and can be administered to an entire classroom in about 10 minutes. Each item presents a brief, simply-worded statement about reading, followed by four pictures of Garfield. Each pose is designed to depict a different emotional state, ranging from very positive to very negative.

Administration

Begin by telling students that you wish to find out how they feel about reading. Emphasize that this is *not* a test and that there are no "right" answers. Encourage sincerity.

Distribute the survey forms and, if you wish to monitor the attitudes of specific students, ask them to write their names in the space at the top. Hold up a copy of the survey so that the students can see the first page. Point to the picture of Garfield at the far left of the first item. Ask the students to look at this same picture on their own survey form. Discuss with them the mood Garfield seems to be in (very happy). Then move to the next picture and again discuss Garfield's mood (this time, a *little* happy). In the same way, move to the third and fourth pictures and talk about Garfield's moods—a little upset and very upset. It is helpful to point out the position of Garfield's *mouth*, especially in the middle two figures.

Explain that together you will read some statements about reading and that the students should think about how they feel about each statement. They should then circle the picture of Garfield that is closest to their own feelings. (Emphasize that the students should respond according to their own feelings, not as Garfield might respond!) Read each item aloud slowly and distinctly; then read it a second time while students are thinking. Be sure to read the item *number* and to remind students of page numbers when new pages are reached.

Scoring

To score the survey, count four points for each leftmost (happiest) Garfield circled, three for each slightly smiling Garfield, two for each mildly upset Garfield, and one point for each very upset (rightmost) Garfield. Three scores for each student can be obtained: the total for the first 10 items, the total for the second 10, and a composite total. The first half of the survey relates to attitude toward recreational reading; the second half relates to attitude toward academic aspects of reading.

Interpretation

You can interpret scores in two ways. One is to note informally where the score falls in regard to the four nodes of the scale. A total score of 50, for example, would fall about mid-way on the scale, between the slightly happy and slightly upset figures, therefore indicating a relatively indifferent overall attitude toward reading. The other approach is more formal. It involves converting the raw scores into percentile ranks by means of Table 1. Be sure to use the norms for the right grade level and to note the column headings (Rec = recreational reading, Aca = academic reading, Tot = total score). If you wish to determine the average percentile rank for your class, average the raw scores first; then use the table to locate the percentile rank corresponding to the raw score mean. Percentile ranks cannot be averaged directly.

APPENDIX

Technical aspects of the Elementary Reading Attitude Survey

The norming project

To create norms for the interpretation of scores, a large-scale study was conducted in late January, 1989, at which time the survey was administered to 18,138 students in Grades 1-6. A number of steps were taken to achieve a sample that was sufficiently stratified (i.e., reflective of the American population) to allow confident generalizations. Children were drawn from 95 school districts in 38 U.S. states. The number of girls exceeded by only 5 the number of boys. Ethnic distribution of the sample was also close to that of the U.S. population (*Statistical abstract of the United States*, 1989). The proportion of Blacks (9.5%) was within 3% of the national proportion, while the proportion of Hispanics (6.2%) was within 2%.

Percentile ranks at each grade for both subscales and the full scale are presented in Table 1. These data can be used to compare individual students' scores with the national sample and they can be interpreted like achievement-test percentile ranks.

Table 1
Mid-year percentile ranks by grade and scale

Raw Scr	Grade 1			Grade 2			Grade 3			Grade 4			Grade 5			Grade 6		
	Rec	Aca	Tot	Rec	Aca	Tot	Rec	Aca	Tot	Rec	Aca	Tot	Rec	Aca	Tot	Rec	Aca	Tot
80			99			99			99			99			99			99
79			95			96			98			99			99			99
78			93			95			97			98			99			99
77			92			94			97			98			99			99
76			90			93			96			97			98			99
75			88			92			95			96			98			99
74			86			90			94			95			97			99
73			84			88			92			94			97			98
72			82			86			91			93			96			98
71			80			84			89			91			95			97
70			78			82			86			89			94			96
69			75			79			84			88			92			95
68			72			77			81			86			91			93
67			69			74			79			83			89			92
66			66			71			76			80			87			90
65			62			69			73			78			84			88
64			59			66			70			75			82			86
63			55			63			67			72			79			84
62			52			60			64			69			76			82
61			49			57			61			66			73			79
60			45			54			58			62			70			76
59			43			51			55			59			67			73
58			40			47			51			56			64			69
57			37			45			48			53			61			66
56			34			41			44			48			57			62
55			31			38			41			45			53			58
54			28			35			38			41			50			55
53			25			32			34			38			46			52
52			22			29			31			35			42			48
51			20			26			28			32			39			44
50			18			23			25			28			36			40
49			15			20			23			26			33			37
48			13			18			20			23			29			33
47			12			15			17			20			26			30
46			10			13			15			18			23			27
45			8			11			13			16			20			25
44			7			9			11			13			17			22
43			6			8			9			12			15			20
42			5			7			8			10			13			17
41			5			6			7			9			12			15
40	99	99	4	99	99	5	99	99	6	99	99	7	99	99	10	99	99	13
39	92	91	3	94	94	4	96	97	5	97	98	6	98	99	9	99	99	12
38	89	88	3	92	92	3	94	95	4	95	97	5	96	98	8	97	99	10

37	86	85	2	88	89	2	90	93	3	92	95	4	94	98	7	95	99	8
36	81	79	2	84	85	2	87	91	2	88	93	3	91	96	6	92	98	7
35	77	75	1	79	81	1	81	88	2	84	90	3	87	95	4	88	97	6
34	72	69	1	74	78	1	75	83	2	78	87	2	82	93	4	83	95	5
33	65	63	1	68	73	1	69	79	1	72	83	2	77	90	3	79	93	4
32	58	58	1	62	67	1	63	74	1	66	79	1	71	86	3	74	91	3
31	52	53	1	56	62	1	57	69	0	60	75	1	65	82	2	69	87	2
30	44	49	1	50	57	0	51	63	0	54	70	1	59	77	1	63	82	2
29	38	44	0	44	51	0	45	58	0	47	64	1	53	71	1	58	78	1
28	32	39	0	37	46	0	38	52	0	41	58	1	48	66	1	51	73	1
27	26	34	0	31	41	0	33	47	0	35	52	1	42	60	1	46	67	1
26	21	30	0	25	37	0	26	41	0	29	46	0	36	54	0	39	60	1
25	17	25	0	20	32	0	21	35	0	23	40	0	30	49	0	34	54	0
24	12	21	0	15	27	0	17	31	0	19	35	0	25	42	0	29	49	0
23	9	18	0	11	23	0	13	26	0	14	29	0	20	37	0	24	42	0
22	7	14	0	8	18	0	9	22	0	11	25	0	16	31	0	19	36	0
21	5	11	0	6	15	0	6	18	0	9	20	0	13	26	0	15	30	0
20	4	9	0	4	11	0	5	14	0	6	16	0	10	21	0	12	24	0
19	2	7		2	8		3	11		5	13		7	17		10	20	
18	2	5		2	6		2	8		3	9		6	13		8	15	
17	1	4		1	5		1	5		2	7		4	9		6	11	
16	1	3		1	3		1	4		2	5		3	6		4	8	
15	0	2		0	2		0	3		1	3		2	4		3	6	
14	0	2		0	1		0	1		1	2		1	2		1	3	
13	0	1		0	1		0	1		0	1		1	2		1	2	
12	0	1		0	0		0	0		0	1		0	1		0	1	
11	0	0		0	0		0	0		0	0		0	0		0	0	
10	0	0		0	0		0	0		0	0		0	0		0	0	

Reliability

Cronbach's alpha, a statistic developed primarily to measure the internal consistency of attitude scales (Cronbach, 1951), was calculated at each grade level for both subscales and for the composite score. These coefficients ranged from .74 to .89 and are presented in Table 2.

It is interesting that with only two exceptions, coefficients were .80 or higher. These were for the recreational subscale at Grades 1 and 2. It is possible that the stability of young children's attitudes toward leisure reading grows with their decoding ability and familiarity with reading as a pastime.

Table 2
Descriptive statistics and internal consistency measures

Grade	N	Recreational Subscale					Academic Subscale					Full Scale (Total)			
		M	SD	SeM	Alpha ^a		M	SD	SeM	Alpha		M	SD	SeM	Alpha
1	2,518	31.0	5.7	2.9	.74		30.1	6.8	3.0	.81		61.0	11.4	4.1	.87
2	2,974	30.3	5.7	2.7	.78		28.8	6.7	2.9	.81		59.1	11.4	3.9	.88
3	3,151	30.0	5.6	2.5	.80		27.8	6.4	2.8	.81		57.8	10.9	3.8	.88
4	3,679	29.5	5.8	2.4	.83		26.9	6.3	2.6	.83		56.5	11.0	3.6	.89
5	3,374	28.5	6.1	2.3	.86		25.6	6.0	2.5	.82		54.1	10.8	3.6	.89
6	2,442	27.9	6.2	2.2	.87		24.7	5.8	2.5	.81		52.5	10.6	3.5	.89
All	18,138	29.5	5.9	2.5	.82		27.3	6.6	2.7	.83		56.8	11.3	3.7	.89

^aCronbach's alpha (Cronbach, 1951).

Validity

Evidence of construct validity was gathered by several means. For the recreational subscale, students in the national norming group were asked (a) whether a public library was available to them and (b) whether they currently had a library card. Those to whom libraries were available were separated into two groups (those with and without cards) and their recreational scores were compared. Cardholders had significantly higher ($p < .001$) recreational scores ($M = 30.0$) than noncardholders ($M = 28.9$), evidence of the subscale's validity in that scores varied predictably with an outside criterion.

A second test compared students who presently had books checked out from their school library versus students who did not. The comparison was limited to children whose teachers reported not requiring them to check out books. The means of the two groups varied significantly ($p < .001$), and children with books checked out scored higher ($M = 29.2$) than those who had no books checked out ($M = 27.3$).

A further test of the recreational subscale compared students who reported watching an average of less than 1 hour of television per night with students who reported watching more than 2 hours per night. The recreational mean for the low televiewing group (31.5) significantly exceeded ($p < .001$) the mean of the heavy televiewing group (28.6). Thus, the amount of television watched varied inversely with children's attitudes toward recreational reading.

The validity of the academic subscale was tested by examining the relationship of scores to reading ability. Teachers categorized norm-group children as having low, average, or high overall reading ability. Mean subscale scores of the high-ability readers ($M = 27.7$) significantly exceeded the mean of low-ability readers ($M = 27.0$, $p < .001$), evidence that scores were reflective of how the students truly felt about reading for academic purposes.

The relationship between the subscales was also investigated. It was hypothesized that children's attitudes toward recreational and academic reading would be moderately but not highly correlated. Facility with reading is likely to affect these two areas similarly, resulting in similar attitude scores. Nevertheless, it is easy to imagine children prone to read for pleasure but disenchanted with assigned reading and children academically engaged but without interest in reading outside of school. The intersubscale correlation coefficient was .64, which meant that just 41% of the variance in one set of scores could be accounted for by the other. It is reasonable to suggest that the two subscales, while related, also reflect dissimilar factors—a desired outcome.

To tell more precisely whether the traits measured by the survey corresponded to the two subscales, factor analyses were conducted. Both used the unweighted least squares method of extraction and a varimax rotation. The first analysis permitted factors to be identified liberally (using a limit equal to the smallest eigenvalue greater than 1). Three factors were identified. Of the 10 items comprising the academic subscale, 9 loaded predominantly on a single factor while the 10th (item 13) loaded nearly equally on all three factors. A second factor was dominated by 7 items of the recreational subscale, while 3 of the recreational items (6, 9, and 10) loaded principally on a third factor. These items did, however, load more heavily on the second (recreational) factor than on the first (academic). A second analysis constrained the identification of factors to two. This time, with one exception, all items loaded cleanly on factors associated with the two subscales. The exception was item 13, which could have been interpreted as a recreational item and thus apparently involved a slight ambiguity. Taken together, the factor analyses produced evidence extremely supportive of the claim that the survey's two subscales reflect discrete aspects of reading attitude.

APPENDIX IV
SUPPLEMENTARY SURVEY

Supplementary Survey

Use √= yes x=no

ID. #	Gender	Do you have a computer at home?	Do you presently have any books borrowed from either the public or school libraries?
1	m		
2	m		
3	m		
4	m		
5	m		
6	m		
7	f		
8	f		
9	f		
10	f		
11	f		
12	f		
13	f		
14	m		
15	m		
16	m		
17	m		
18	m		
19	m		
20	f		
21	f		
22	f		
23	f		
24	f		
25	f		
26	f		

APPENDIX V
RAW DATA

Raw Data: Reading Comprehensions Test Results

Subject ID #	Gender	T1 <i>Thomas' Snowsuit</i>	T2 <i>Tale of Benjamin Bunny</i>	T3 <i>Northern Lights</i>	T4 <i>Strega Nona Meets Her Match</i>	Reading Level Grade	Lan-guage Group 1=ESL 2=non ESL
		Print	Print	CD-ROM	CD-ROM		
1	M	23	20.5	18	19	3	2
2	M	20	18	16.5	17	3	2
3	M	19.5	10	20.5	17.5	2	2
4	M	17	13	18	13	2	2
5	M	12	4	22	12	1	2
6	M	9	7	14	5.5	1	1
7	F	22.5	18.5	20.5	21	3	2
8	F	22	19	21.5	20	3	2
9	F	20	14.5	18	16	2	2
10	F	20.5	13.5	20.5	22.5	2	2
11	F	20	14.5	15.5	15	1	2
12	F	15	13.5	20	14	1	2
13	F	19.5	9	20	15	1	2
		CD-ROM	CD-ROM	Print	Print		
14	M	19.5 CODE 99	Withdrawn CODE 99	Withdrawn CODE 99	Withdrawn CODE 99	3	2
15	M	22	21	17.5	20	3	1
16	M	16.5	15	18.5	16	2	1
17	M	20	20.5	17	20	1	2
18	M	21	15	13.5	6.5	1	1
19	M	22.5	7	14.5	8	1	2
20	F	18	17	20	23	3	2
21	F	18.5	17	18	18	3	2
22	F	19	14	19.5	13	2	1
23	F	17	18.5	20	14.5	2	2
24	F	13.5	20.5	15	10.5	1	1
25	F	13	20.5	14.5	9	1	2
26	F	20	8.5	16	14	1	1

*Maximum score is 24 for each test.

Raw Data: Reading Attitude Pre/Posttest Results

Subject ID. #	Pretest Reading Attitude: Recreational	Pretest Reading Attitude: Academic	Pretest Recreational & Academic Combined	Posttest Reading Attitude: Recreational	Posttest Reading Attitude: Academic	Posttest Recreational & Academic Combined
1	40	37	77	40	40	80
2	40	40	80	40	40	80
3	34	29	63	33	28	61
4	40	40	80	36	34	70
5	24	27	51	25	21	46
6	28	33	61	35	40	75
7	34	31	65	30	33	63
8	40	40	80	40	40	80
9	25	33	58	23	26	49
10	40	39	79	40	40	80
11	30	37	67	34	33	67
12	36	33	69	30	29	59
13	30	29	59	26	26	52
14	33	39	withdrawn CODE 99	-	-	withdrawn CODE 99
15	34	38	72	28	39	67
16	35	36	71	29	28	57
17	25	25	50	26	27	53
18	37	38	75	37	38	75
19	32	25	57	33	39	72
20	38	34	72	34	39	73
21	36	35	71	38	35	73
22	36	28	64	38	33	71
23	32	32	64	30	28	58
24	35	39	74	38	36	74
25	35	34	69	31	34	65
26	31	34	65	32	34	66

* Maximum score on attitude test is 80 (40 for each of the subtests)

Raw Data: Supplementary Survey √= yes x=no

ID. #	Gender	Do you have a computer at home?	Do you presently have any books borrowed from either the public or school libraries?
1	m	√	x
2	m	x	x
3	m	√	x
4	m	√	√
5	m	√	√
6	m	√	x
7	f	√	√
8	f	x	x
9	f	√	x
10	f	√	√
11	f	x	√
12	f	x	√
13	f	x	x
14	m	withdrawn	withdrawn
15	m	√	√
16	m	x	x
17	m	x	x
18	m	x	x
19	m	x	√
20	f	√	x
21	f	√	√
22	f	x	x
23	f	x	√
24	f	√	x
25	f	√	x
26	f	x	x

Raw Data: Reading Comprehension Test Results Organized According To Pearson and Johnson's Question-Answer Relationship Taxonomy

Subject ID #	PRINT Text Explicit T1 & T2	PRINT Text Implicit T1 & T2	PRINT Script Implicit T1 & T2	CD-ROM Text Explicit T3 & T4	CD-ROM Text Implicit T3 & T4	CD-ROM Script Implicit T3 & T4
1	15.5	13.5	14.5	13	9	15
2	14	13	11	12	9.5	12
3	11	9	9.5	13	12	13
4	12.5	10.5	7	11.5	9.5	10
5	4	5.5	6.5	11.5	11.5	11
6	6	3	7	6	6	7.5
7	16	14	11	15.5	11.5	14.5
8	16	14	11	15	13.5	13
9	13	9	12.5	13	8.5	12.5
10	11	13	10	15.5	12	15.5
11	16	9	9.5	14.5	8.5	7.5
12	10.5	8	10	11	10.5	12.5
13	10	9	9.5	13.5	8.5	13
	CD-ROM Text Explicit T1 & T2	CD-ROM Text Implicit T1 & T2	CD-ROM Script Implicit T1 & T2	PRINT Text Explicit T3 & T4	PRINT Text Implicit T3 & T4	PRINT Script Implicit T3 & T4
14	Withdrawn	Withdrawn	Withdrawn	Withdrawn	Withdrawn	Withdrawn
15	15	13	15	13.5	9.5	14.5
16	12.5	9.5	9.5	13.5	9.5	11.5
17	16	12	12.5	13.5	11.5	12
18	16	9.5	10.5	4	7.5	8.5
19	10	8	11.5	7.5	6	9
20	13	11	11	14.5	12.5	16
21	14	9.5	12	11	11	14
22	15	10	8	12.5	7.5	12.5
23	14	7	14.5	12.5	9	13
24	13	11	10	10.5	5	10
25	12	9	12.5	11	6	6.5
26	8.5	8	12	9.5	9.5	11