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ABSTRACT

A review of the literature investigated how computers have been used in relation to the teaching of reading over the last 20 years, how effective those endeavors and research studies (mainly conducted at the college level) have been, and what computer instructional programs in the area of reading need to address. Various efforts have been made to include the computer in the reading classroom as an instructional tool. Research has also been carried out to determine and assess the effectiveness of various kinds of computer uses, programs, and interventions in terms of improvement in reading achievement and comprehension. Despite these efforts, some of these programs have failed to include a sound pedagogical foundation or theoretical base in terms of how reading should be taught, and what should be emphasized in a reading program or curriculum. Reading, although it has been defined in a number of complex ways, can in general terms, best be defined as a process which involves the reader, the text, and the interaction between reader and text. It is important that computer programs designed to teach reading be based on such knowledge about the reading process. Effective and successful reading computer programs are those that generate student participation. One of the more recent computer endeavors that carefully considers the second-language reading process is known as GALT (Glossing Authentic Language Texts). Computer assisted instruction and computer programs to teach reading hold great promise for becoming powerful instructional tools that increase students' engagement in reading, enhance reading comprehension, and improve reading skills. (RS)

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Using Computers as Reading Instructional Tools: Applications and Implications

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Introduction

Computer development and technical advancements have been burgeoning during the last twenty years. Improvements in the efficiency and quality, and refinements in computers and software, along with decreased costs have made computer technology more and more accessible. Despite these advances, and given that reading development and instruction is a pedagogical priority at all academic levels, the impact of computers on the teaching of reading has been minimal. Although there have been numerous uses of computers in the area of reading, the possibilities for computer use in the reading classroom far outweigh many existing practices. At the same time, while many schools are training teachers to be computer literate, there appears to be less training concerning the effective use of computers as an educational tool.

This paper will investigate the role of the computer as it relates to reading. More specifically, the following questions will be addressed: 1) How have computers been used in relation to the teaching of reading over the last twenty years? 2) How effective or ineffective have these endeavors and research studies been? 3) Given the current theoretical views of reading, what do computer instructional programs in the area of reading need to address? This discussion will include a review of the relevant literature from both L1 and L2 contexts in order to provide the reader with a broader understanding of computer use and the connections to the teaching of reading. Furthermore, it must be pointed out that most of the studies reviewed here examine computer use and reading at the college levels.

Background and Literature Review

Interest in using computers to enhance learning began in the mid 1960's (Rupley & Chevrette, 1983; Thompson, 1980). The first well-known study to develop these programs was the Stanford Computer Assisted Instruction. This was an on-going study to develop programs capable of individualized reading instruction for kindergarten through third grade. Simultaneously, two counterpart projects, TICCIT and PLATO began to develop computer-based strategies for learning to read. The goal of the project was to develop a complete curriculum for all grade levels. Over time, however, these initiatives gradually faded. In the seventies, other research projects examined computer use and reading, and various studies were conducted to determine how specific computer programs affected students' reading ability. Fletcher and Atkinson (1972) conducted one of the earlier studies in which children of an

experimental group received eight to ten minutes of computer assisted instruction per day for five months; the remainder of the day was the same for all children. Results of post-test gain scores showed that most students who received CAI performed better than those who did not.

At the CAI Laboratory at the Pennsylvania State University, a program was developed for students aged 14-24 years. These students were diagnosed as having low reading skills. Phase 1 of the program focused on initial reading and job orientation, while Phase 2 of the program focused on career oriented reading in various job areas. After ten hours of computer assisted instruction, the students' reading showed marked improvement. In a similar type of investigation, Fletcher and Suppes (1972) used the Computer Curriculum Corporation reading curriculum for grades four to six with 162 students, ten minutes a day for the entire school year. They found that students covered twice as many new words as students using traditional basal texts only. In essence, many of the studies conducted in the seventies were research projects that addressed major issues related to student achievement with computer assisted instruction.

In the eighties and nineties, many studies involved the implementation of courses which combined the teaching of reading skills with computer aids that provided various types of support. One such study was carried out at Duquesne University in Pennsylvania (Orndorff, 1987). The rationale behind the development of such a program was that it was believed many college students lacked the ability to read and think critically. Generally, those students who achieved high marks in university, were those that were better readers. The researchers employed two computer programs in the sequence of two courses in critical reading and thinking. The program "Abstract" was designed to teach students how to analyze a work for literary genre and structure, and 0was designed to be used with a book in hand. The program "Interlocutor" allowed teachers to create tutorials which featured various kinds of question and answer formats, screen manipulations, and the ability to have an on-line dictionary of words and concepts. Various activities included summary writing, short essay questions, sections which focused on form of the texts, and quizzes. The author points out that because of such programs, both student achievement and retention levels increased.

Krasilnikov (1989) describes a course developed in Russia using computer assisted instruction for the development of second language reading skills. Nine computer programs consisting of learning modules were developed to address specific reading skills not likely to have been attained by students at that level of second language literacy. The modules provided

practice in word recognition and word comprehension, recognition of word boundaries and sentence structures, recognition of the devices used to create textual cohesion, sentence completion, vocabulary development, skimming skills, scanning, and practice in reading for global understanding, and reading for total comprehension. While the effects of this particular program are not discussed as this was merely a description of a computer program created to teach specific reading skills, the creators of these modules do emphasize the teaching of particular skills, although this is not comprehensive by any means. In addition, the activities described appear to provide practice in both top-down and bottom-up reading comprehension strategies.

A study by Arroyo (1992) examined the effect of extended use of computers on reading achievement. The subjects consisted of 75 grade seven students attending an elementary school located in a predominantly low income socio-economic neighborhood of South Chicago. Of this total, 15 students were subjected to an intensive computer assisted instruction program for the entire school year, while 15 others, randomly selected from the remaining group of 60 received no computer training and served as a control group. Results of the Iowa Tests of Basic Skills indicated a statistically significant increase in reading achievement of the students who used computers. In addition to an improvement in reading scores, Arroyo also points out that use of the computer also appeared to increase student motivation to learn.

Computer instruction or intervention has also been used to improve reading rate and efficiency. Wepner, Feeley and Wilde (1989) conducted a study to assess whether a commercially prepared reading package, *Speed Reader*, could be utilized as effectively as traditionally printed paper text with college students over time to improve reading efficiency, namely, rate and comprehension. Two of four sections of a second-level basic skills course were randomly designated as the experimental group and the other two were control groups. All sections read a novel and spent one period a week using *Speed Reader II* materials. The only difference was in the mode of delivery as the experimental group used the materials in the computer lab and read passages on a computer screen. At the end of eight weeks, all students were tested using the Fast Reading Section of the Stanford Diagnostic Reading Test. While no significant differences in rate gain were found, different reading efficiency patterns were found for the experimental group. The authors conclude that computers can be used as effectively as traditional approaches in delivering timed, whole text readings with comprehension checks to

improve the reading efficiency of college students. In addition, motivation benefits were also observed for the computer-displayed group.

Adler-Kassner and Reynolds (1996) also implemented computer use in basic composition classes at the University of Minnesota's General College. Although specific computer assisted instruction packages were not utilized, the computer was used as a reading tool in order to help students become more aware of their reading processes. Real-time conferencing was used so that students could engage in real-time discussions about texts and various questions they had about their readings. Students also had opportunities to enter into dialogic readings with one another or with an instructor through electronic mail. Overall, the researchers found that students tended to disclose more about their interaction with readings over email than they did in the classroom. The authors also point out that the feedback students received in terms of email responses also strengthened confidence about their encounters with unfamiliar academic texts.

In addition to these types of uses, students were also shown how to use web browsers and electronic library databases in order to locate other sources and make connections to their texts and readings. The main goal was to show students how to read widely across several documents or screens, with the purpose of enhancing their responses to texts. In effect, these efforts were intended to help students make links from their individual texts to authoritative academic texts.

In addition to the studies described above, more recent studies in the area of computers and reading have examined the effects of multimedia reading software on reading comprehension. Lomicka's (1997) study aimed to explore how multimedia annotations influence the level of comprehension. Twelve college students enrolled in a second semester French course were instructed to think aloud during the reading of text on the computer screen. Participants read the text under one of three conditions: full glossing, limited glossing, or no glossing. In addition, a tracker was set up in the software to record the amount and type of glosses, and length of time that each was consulted. The data indicated an increase in the number of causal inferences generated for students who had access to full glossing. She concluded that computerized reading with full glossing may promote a deeper level of text comprehension.

Lyman-Hager et al. (1993) also examined vocabulary acquisition and student glossing choices for intermediate level students studying French. Lyman-Hager et al. concluded that students who worked with the multimedia program based on an excerpt from the story by F. Oyono, *Une Vie de Boy*, were better able to retain vocabulary words than students who worked

with non-computerized text. Two conditions were used in this study: computerized reading and non-computerized reading. Both groups had access to glosses; the computer group had access to multimedia annotations, while the text group could consult printed text with the same glosses. Subjects were asked to perform a written recall protocol immediately after reading the text. A week later, an in-class vocabulary quiz of "critical" words in the story was distributed following a class discussion.

In an article exploring multimedia annotations and vocabulary acquisition, Chun and Plass (1996) present the results of three studies with students in their second year of German who used *CyberBuch*, a multimedia application offering annotations through pictures, text, and video. Specifically, the goals of their investigation include exploring incidental vocabulary learning, examining the effectiveness of multimedia annotations, and investigating the relationship between look-up behavior and vocabulary test performance. Students were introduced to the program and watched a video which provided an overview of the story before working with the multimedia application. After reading the story and using the multimedia annotations, students took a vocabulary test and wrote a recall protocol. Chun and Plass (1996) report that the recall protocol for visual annotations (i.e., words annotated with text and pictures, text, and video) was higher than for words annotated with text alone. While both Lyman-Hager et al. (1993) and Chun and Plass (1996) investigated vocabulary learning through the use of recall protocols, some researchers point out that recall or post-reading measures may be more representative of a memory test used to simply "recall" knowledge.

Effectiveness of Computer-Based Reading Instructional Programs and Research Studies

It is clear from the above discussion that various efforts have been made to include the computer in the reading classroom as an instructional tool. Research has also been carried out to determine and assess the effectiveness of various kinds of computer uses, programs, and interventions in terms of improvement in reading achievement and comprehension. However, despite these efforts, some of these programs have failed to include a sound pedagogical foundation or theoretical base in terms of how reading should be taught, and what should be emphasized in a reading program or curriculum.

It is important to recognize that many studies that show benefits of CAI in relation to reading involved short-term instruction and then measured gains in reading achievement. One

would expect an immediate improvement after a few hours or days of instruction, even due to memory effects, but there is often no follow-up in these studies to ensure whether students have in fact learned specific reading strategies and skills in order to effectively and efficiently apply them to future tasks. Other projects have instituted various computer instructional programs in their existing curriculum, but again little information is provided as to how students have in fact benefited from such instruction. While the goals of the program are clear, the results are less straightforward because some of the studies described above do not provide such information. Furthermore, those studies that do emphasize the teaching of specific skills and strategies (Krasilnikov, 1989; Orndorff, 1987) via the computer do not seem to present information within a context. For the most part, the exercises are isolated drill and practice type activities. Numerous studies have also focused on reading speed and accuracy of decoding, rather than on meaning-making and overall comprehension (Warren and Rosebery, 1988; Wepner, Feeley, & Wilde, 1989). In such studies, the process of reading is viewed solely as a bottom-up process in which students are focused on aspects of the text itself such as individual words and sentence structure. Many studies to date in this area have been concerned with gains in reading achievement based on pre- and posttest scores. Finally, the more recent studies examining effects of multimedia reading software on reading comprehension, and the research on glossing and multimedia annotations, have concentrated primarily on vocabulary learning, acquisition, and retention, and have only scratched the surface of research involving computer-assisted reading comprehension and multimedia annotations. Few studies have been longitudinal and have failed to implement programs that teach students a range of reading strategies/skills to become more aware of their own reading processes, and to use strategies effectively in different reading contexts in order to make sense of what they read. Based on such an analysis, it is clear that current theoretical views about what reading is, and what the reading process entails need to be considered when both designing and implementing computer programs for reading instruction.

The Reading Process and Computer Applications

Reading, although it has been defined in a number of complex ways, can in general terms, best be defined as a process which involves the reader, the text, and the interaction between reader and text (Goodman, 1996; Rumelhart, 1977). This interaction can occur through reading strategies and through schema. For example, researchers have attempted to identify the

mental activities that readers use in order to construct meaning from a text (Anderson, et al. 1991; Devine 1988; Hosenfeld et al 1981). These activities are referred to as reading strategies or reading skills In essence, reading is an active process in which readers use powerful strategies in the pursuit of meaning. Research in this area has shown that successful readers use different strategies than less successful readers and also use strategies more frequently and more effectively than less successful readers (Anderson, 1991; Block, 1986; Carrell, 1989; Devine, 1987; Hosenfeld, 1977). Successful readers recognize words quickly, use text features, use contextual clues, use word knowledge, identify grammatical functions of words, make guesses, monitor comprehension, paraphrase, predict, understand relationships between parts of texts, recognize rhetorical patterns, and reading for meaning. While this list is by no means exhaustive, research has shown that good readers possess a number of flexible, adaptable strategies that they use before, during, and after reading to maximize comprehension. Other studies in the area of strategy use and reading have shown that strategy training or instruction can enhance reading comprehension (Carrell, Pharis and Liberto, 1989; Jimenez and Gamez, 1996; Kern, 1989).

In addition to the research on strategy use and reading, the theory of schema has had a great impact on understanding reading, and researchers have identified several specific types of schemata. Content schema provides readers with a foundation, a basis for comparison, and refers to background or cultural/social knowledge (Carrell and Eisterhold, 1983). Formal schema refers directly to the organizational forms and rhetorical structures of written texts, and linguistic schema includes the decoding features in text such as words and sentence structures. Numerous studies have verified that students understand more of a text when they know content and formal schema (Carrell, 1987; Johnson, 1981; Johnson, 1982).

In looking for ways to describe the interaction between reader and text, researchers have also created models that describe what happens when people read. Bottom-up theory argues that the reader constructs the text from the smallest units, from letter to words, and words to sentences. This process is essentially known as decoding. Top-down theory argues that readers bring a great deal of knowledge, expectations, and assumptions to the text. Readers fit the text into cultural, syntactic, linguistic, and historical knowledge that they already possess. And lastly, the interactive theorists, which most researchers currently endorse, argues that both top-down and bottom-up processes are occurring either alternately or simultaneously. In other words, good

readers make use of both top-down and bottom-up strategies when reading, depending on the situation, and the task and text (Carrell, Devine, & Eskey, 1988).

Given what we currently know about the reading process, it is important that computer instruction, and computer programs designed to teach reading are based on such knowledge about the reading process. First, it is essential to recognize that before computers are used in the reading class, teachers should have clearly identified objectives and goal for their class. Specific goals will of course vary, but they may include developing an awareness of reading strategies necessary for efficient reading, expanding vocabulary, developing an awareness of rhetorical structures found in academic texts, and so forth. Programs designed or chosen for classroom use will therefore depend on the overall purpose. Second, teachers must also be aware that there are many different types of software available for reading. Some of these programs focus on specific skills, and others focus on a wide range of reading strategies and skills. While many excellent programs are available, others are less stimulating and devoid of instructional potential. When selecting software, teachers should diligently peruse the existing literature and consult experts to obtain information in this area.

Teachers must also ensure that computer programs in some way address reading strategies/skills, as extensive research has shown that successful reading requires the knowledge and implementation of strategies, and strategy instruction can improve reading comprehension. Lessons and activities, for example, might include making predictions based on given information, identifying text structure, defining words based on context, paraphrasing, answering comprehension questions, scanning for information, identifying rhetorical patterns, and so forth Such activities can be done through drill-and-practice activities, the tutorial modes of CAI, or through problem-solving games and simulations on the computer. Regardless of which type of activity the teacher employs, variety is important so that students do not lose interest, and hence motivation.

Effective and successful reading computer programs are those that generate students participation. The student cannot simply employ the process of eliminating and guessing until all choices have been exhausted. An example of a good program is one in which the student has to both identify and type in answers, complete sentences or paragraphs, or write ending or parts of texts and stories. Word processing programs in combination with activities that teach reading skills, by their very nature, also require active involvement. An appropriate computer program

must contain reading selections that are varied in a wide range of grade levels, but must also be uniformly suitable in terms of students' ages and interest. Older students, or more advanced-level students will be unmotivated by stories that are too easy for them, for example. The programs should contain a variety of selections wherever possible and reading materials and activities should be tied to classroom content in order for such activities to take place within a meaningful context. Variety of text material will also provide students with exposure to different genres, and hence different rhetorical patterns which they need to become familiar with as readers. For example, a unit on environment preservation might include a series of texts related to this particular thematic unit, but texts may vary in that they could be argumentative, cause and effect, or problem-solution texts. Teachers must also ensure that texts used are of optimal difficulty level and are not too easy, nor too difficult for students. Many computer programs can be individualized to some extent. Interactive programs, for example, can allow more "flow," where the student does not get trapped into a particular sequence or become locked into an author's predetermined plan. In this medium, students can request more information or reviews, solicit an exercise, quiz, or other background information such as additional texts or contextual information relevant to the text, obtain a dictionary, or ask for additional examples. Interactive reading programs vary a great deal, but they offer students flexibility since they can proceed at their own pace and in the sequence in which they choose. Many current programs also contain a measurement component which can provide feedback to the student in various forms.

One of the more recent computer endeavors that carefully considers the L2 reading process was designed by Lyman-Hager and a team from Penn State's Educational Technology Services developed the template-based shell known as GALT (Glossing Authentic Language Texts). This model defines reading comprehension as a result of multiple interacting factors: word recognition (understanding individual word meanings), phonemic/graphophonic decoding (recognizing words through aural or visual characters), syntactic feature recognition (understanding grammatical relationships), intratextual perception (linking statements to those that precede or follow), prior knowledge (awareness of knowledge brought to text), and metacognition (awareness of reader's own cognitive processes during the reading process) (Davis & Lyman-Hager, 1997). Davis and Lyman-Hager carefully ex plain how the different interacting factors correspond with different types of multimedia annotations. Students can click on words or expressions to obtain definitions in English or in the target language (word recognition). To

prevent phonemic/graphophonic errors, readers use the pronunciation feature in order to hear words or passages spoken by a native speaker. Further, students could access grammatical notes and explanations to enhance textual understanding (syntactic feature recognition). In an attempt to enhance global comprehension and to assist students in linking statements and ideas, readers are able to click on a question control button (intratextual perception). Cultural knowledge is provided to readers both during their reading (through a cultural reference control button) and in the introduction to the text, to the author, and/or to the author's country of origin (prior knowledge). Finally, the tracking device allows instructors/researchers to obtain a log of readers' strategies for gathering information. While this is by no means the only such program available, it does attempt to apply the current theoretical models of reading to a computer instructional program and can also keep a record of the student's strategy use, a unique feature, which can allow teachers to determine where comprehension and miscomprehension occurred.

Conclusion

In essence, computer assisted instruction and computer programs to teach reading hold great promise for becoming powerful instructional tools that increase students' engagement in reading, enhance reading comprehension, and improve reading skills. Such tools can also assist the teacher in developing a truly individualized reading program that can better meet the varied needs of students found in most classrooms. By using such a tool, teachers can vary the pace of instruction, review and reinforce learning, teach and address specific skills, enhance motivation, and provide immediate feedback. These features combined increase the likelihood that students' engagement in reading instruction will be increased. Having said that, it must be recognized that the computer is not meant to replace the teacher, but rather improve and enhance classroom reading instruction. Well-designed multimedia computer programs can allow students to apply what they learn in meaningful reading activities that meet their individual needs, and such programs can also stimulate interest and increase motivation. Instructional programs can be developed to teach reading and comprehension skills and strategies that go beyond simple busy tasks that students often respond negatively to. Reading instruction via the computer has the potential to actively engage students in the reading and learning process because of its capabilities to meet their varying needs, and can help students perceive the value of success, and their own potential as readers.

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