AVC - Calgary
Computer Assisted
Reading Instruction Project

Evaluation Report

Prepared for

Alberta Vocational College - Calgary
Alberta Advanced Education and Career Development
National Literacy Secretariat

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Alberta Vocational College - Calgary

Computer Assisted Reading Instruction Project

EVALUATION REPORT

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EXECUTIVE SUMMARY

Evidence is increasingly showing that for many teaching and learning situations, computer-assisted instruction (CAI) is an effective method of instruction. With growing numbers of adult learners, the results of research investigating the academic and socio-cultural impact of computer-assisted instruction can offer useful information to those adult education organizations making decisions related to program development and instruction.

In early 1996 a two-year quantitative and qualitative evaluation of computer-assisted reading instruction began at Alberta Vocational College - Calgary, Alberta. Alberta Vocational College is a post-secondary institution providing adult academic upgrading, English as a Second Language and career-entry programs of one year or less in health, business, and service industries.

The purpose of the evaluation[1] was to determine the short- and long-term effectiveness of CAI software in improving the reading skills of three groups of adult upgrading students: Adult Basic Education (ABE) students, English as a Second Language (ESL) students, and Adult Basic Literacy (ABL) students.

The qualitative evaluation collected information about the experiences and perspectives of the students and instructors involved in using CAI. The quantitative assessment considered three variables (sightwords, decoding, and comprehension) in development of reading skills.

[1]This evaluation study was made possible through a partnership between the Canadian Federal Government, the Province of Alberta, a private sector software supplier (Autoskill International), and AVC - Calgary. Funding was made available through the National Literacy Secretariat.

Method

The design of the evaluation was a quasi-experimental, non-randomized, pretest-posttest, control group design. While attempts were made to match control and treatment groups, random assignment of groups was not possible. The independent variable was the CAI program (Autoskill and/or PLATO). The dependent variables were reading performance in sightword recognition, decoding skill, and comprehension.

Treatment

The **Autoskill Reading Program** is a computerized skills-oriented learning resource aimed at promoting the acquisition of skills needed for the mastery of reading.

The **PLATO** (Basic Literacy Skills Reading - Canadian Edition) is a modularized computer-assisted instruction program designed to meet individual learner needs, and to match the objectives of learners' educational or training programs.

Effects of the treatment and a moderator variable (entry-level reading skill) were considered. Groups were combined and grouped according to treatment and control. Analyses were conducted according to: 1) Stage One ABL, ESL, and ABE students, 2) Stage Two ABL, ESL, and ABE students, and 3) Stage One and Two combined ABL, ESL, and ABE students. Groups were further categorized into low, medium, and high reading ability according to pretest results.

Assessments of reading level were conducted using the Bader Inventory, Yopp-Singer Test, and Woodcock-Johnson standardized reading inventory. Data were collected three times (pretest, posttest, 6-month follow-up retention test).

Qualitative data were collected immediately following the treatment in both Stage One and Stage Two from students and instructors. Evaluators observed students using the computer. Both survey and interview techniques were applied.

Evaluation Design

Subject Assignment	Pretest	Treatment Period	Posttest1	Posttest2
Not Random	O_1	X_1	O_2	O_3
Not Random	O_1	No X	O_2	O_3

A total of 167 students were initially registered in the study (84 Stage One, 83 Stage Two). A total of 127 students completed the study.

Results

Results of this study were similar to many other control studies of computer-assisted instruction. A modest to small treatment effect was observed for some variables, but for the most part, no significant differences were observed between the reading performance of students receiving computer-assisted instruction and those receiving the conventional program of studies at AVC - Calgary. Also similar to other studies of this type, is that qualitative results suggest that students in this study enjoyed working with computers and, in many instances, appeared more highly motivated to complete their academic tasks.

Computer Effect

While this study reveals few significant differences between the reading performance of students receiving computer-assisted instruction and those receiving the conventional program of studies, statistical results indicate a gain in reading performance by some groups of students whose program included computer-assisted instruction.

The results of this study suggest that ABL and low initial entry-level readers appear to make greatest gains using CAI programs. This trend may become more significant with increased concentration and sustained used of CAI. High entry level readers did not gain significantly from the versions of Autoskill or PLATO used in this study.

Course Completion

While motivation across groups to use the computer was moderate to high, there appears to be no appreciable difference in the rate with which students successfully completed courses involving computer use.

Integration of CAI

Integration of CAI with conventional face to face instruction with ABE and ABL was higher in the Stage One than in Stage Two. Integration of CAI into the ESL program remained about the same over the two years. As might be expected, where CAI was more fully integrated into instruction, it had a stronger positive effect on student performance, which may suggest that a certain “critical time mass” is required for CAI to be effective.

Student Satisfaction

With the exception of the Autoskill experience for Stage One ABE students, all students in this study reported enjoying their CAI experience. They believed they received some benefit from using the computer. It is interesting to note that ESL students regarded the computer as part of course content rather than

separate from it. In contrast, both ABE and ABL groups reported wanting to "learn" the computer as a tool.

Instructor Satisfaction

Before the study began, instructors received varying amounts of orientation and training on Autoskill. Their satisfaction with the training was mixed, however. Some said training was insufficient; others reported that only experience using Autoskill sufficiently prepared them to teach it. Instructors were very willing to explore CAI and were supportive and cooperative throughout the study. Overall, their satisfaction with CAI was moderate to high.

Challenges to Implementing Controlled Studies

Implementing a comprehensive evaluation study in a fully functioning college is a challenge, especially when evaluations involve elements of control. Creating equivalent treatment and control groups, as well as student attrition posed complications and compromises to the study. Results should therefore be considered within these limitations that point mainly to factors confounding experimental design studies: sample selection and assignment, treatment and control group matching, changes in test instruments, and subject attrition.

Recommendations

The following are some suggestions for the continued use of CAI with adult audiences at AVC - Calgary:

1. **Continued Use of CAI**
   CAI should continue to be used with low and mid-range reading level audiences. Autoskill can be expected to have its best effect with low level readers.

2. **Strategically Use CAI**

   Where used, CAI should be applied in a consistent and concentrated fashion. It should be used strategically and not as a blanket solution for all students.

3. **Use CAI to Reinforce Computer Skills**

   There are some value-added gains in using CAI with students. Additional time on computers reinforces previously and newly learned computer skills such as keyboarding and use of the mouse. In addition, some benefits can be attributed to the computer use in improving student confidence and self-esteem.

4. **Update PLATO**

   PLATO reading software should be updated. The current version at AVC - Calgary cannot take advantage of Windows features on 486 + computers.

5. **Continue to Evaluate Reading Software**

   AVC - Calgary should continue to evaluate reading software, especially those programs which have extensive adult content and approaches to interpret users' intentions, and stimulate mental associations, or, are rich in information resource capabilities.

6. **Continue to Evaluate CAI Use**

   AVC - Calgary should continue to monitor and evaluate the use of CAI with adult learners. Not all learners appear to equally benefit from CAI. Therefore, it is expecially important to better understand which combinations of teaching style, learning style, student entry-level ability, and CAI are best suited to enhancing the academic performance of adult students.

Computer Assisted Reading Instruction Project

Introduction

Traditionally, western cultures have relied on schools or other forms of formalized instruction to teach reading and writing. For the most part, instruction materials continue to be print-based and lessons are delivered by a teacher to a group of students. However, advances in computer and information technology have placed pressure on educational institutions to change some of their strategies toward teaching reading.

From the development of computer-assisted instruction (CAI) on large mainframe computers in the early 1960's, CAI has been heralded as one of the greatest innovations in education. Evidence is showing that for many teaching and learning situations, computer-assisted instruction (CAI) is an effective method of instruction. While most of this evidence comes from research and evaluation with younger, school-based audiences, growing numbers of adult education institutions are showing interest in the academic and socio-cultural impact of computer-assisted instruction on adult students.

This paper reports the results of an evaluation study of computer-assisted reading at Alberta Vocational College - Calgary. The purpose of this study was to determine the short- and long-term effectiveness of computer-assisted instruction (CAI) software in improving the reading skills of three groups of adult upgrading students. The study was intended to assist AVC - Calgary in determining the "usefulness" and "value" of employing computer-assisted reading instruction with adult upgrading students.

This evaluation study was made possible through a partnership between the Canadian Federal Government, the Province of Alberta, a private sector software supplier (Autoskill International), and AVC - Calgary. Funding was made available through the National Literacy Secretariat.

A brief literature review, method and results of the evaluation, including considerations for future use of CAI reading with adult audiences are presented. Quantitative and qualitative data were collected during two stages: Stage One (February 1996 to February 1997) and Stage Two (September 1996 to June 1997).

Literature

In the past few decades (1975-1995) there have been hundreds, if not thousands, of studies conducted in an attempt to clarify the relationship between technology and learning. Usually these studies report the relationship between the use of educational technology and one or more of the following variables: 1) student performance, 2) student attitudes/motivation, and 3) efficiency/cost effectiveness. Where some control has been introduced for instructional method, the more publicized studies have reported no significant difference or modest gains in student performance. Reported effect sizes typically range between .11 and .38 standard deviation units in favour of technology over traditional instruction (Johnson, Cox & Watson, 1994; Khalili & Shashaani, 1994; Metropolitan Educational Research Consortium, 1993; Kulik, Chen-Lin, and Kulik's, 1987). There are, however, complexities in determining the effect of computer-assisted instruction on achievement. Factors such as teachers' and students' attitudes towards technology, extent of integration in the curriculum, user interface with hardware and software, influence the impact of technology on achievement no less than the technology itself.

CAI Studies with Adult Reading Populations

Few CAI studies have concentrated on adult subjects. Where they have, mixed results are reported. A recent meta-analysis by Rachal (1995) examined the effectiveness of computer-assisted instruction (CAI) on the teaching of reading at adult basic and secondary education levels. This meta-analysis included a number of quasi-experimental studies comparing experimental (CAI) groups to groups using more conventional classroom-based instruction. Of the twenty-one studies examined in this meta-analysis, variation was reported in the design, objectives, settings, software, skills examined, and conclusions. While the majority of findings indicated no significant difference in student achievement, five studies reported improvement in achievement scores for CAI over conventional reading approaches. In addition, other benefits were reported: faster rates of learning, immediate feedback, reduced attrition, increased student self-confidence, and increased privacy. These findings were reported as researchers' perceptions rather than empirically derived findings. Studies often suggest using CAI as an adjunct, not a replacement for traditional approaches to teaching and learning (Garza & Gibbs, 1994; VanProoyen & Clouse, 1994; Moore, 1993).

Second and Third Generation CAI

With the advent of increased computer power and swift and accessible telecommunications, development of CAI has increasingly adopted multimedia delivery of

course curriculum. Multimedia software incorporates text, graphics, animation, pictures, video, and sound in what is called "second generation CAI". First generation CAI is defined by the limitations of the medium, primarily forcing learners to engage in simple learning tasks. Second generation CAI increases in complexity of design allowing learners to engage the complex processing, inference making, semantic elaboration and multiple ways of monitoring, sending and retrieving information. Third generation CAI offers a constructivist approach to learning (Goodfellow, 1995).

Research results surrounding this medium are few. Early indications are that learners are better able to acquire vocabulary and improve comprehension, primarily due to the ability of these new programs to assist the learner in making various associations in more realistic and varied contexts (Chun and Plass, 1996a; Chun and Plass, 1996b; Goodfellow, 1995; McBride and Seago, 1996). Also, this new medium is reported to improve student attitude toward subject material and learning in general (Brett, 1996). Another encouraging feature of multimedia delivery is that various media appear to be successful in encouraging learners to take more responsibility for their own learning (McBride and Seago, 1996).

While increased use of multimedia is reported in all aspects of education and training, measurement of its effect on learning will be even more complex and controversial than with first generation CAI. As Najjar (1996, p. 129) suggests, people tend to share a common assumption that multimedia information helps people learn--an assumption "based more on personal opinion than on scientifically-based fact." Najjar goes on to comment that specific situations in which multimedia information may help people to learn include: (a) media encouraging dual coding of information, (b) media supporting other media, and (c) media presented to learners with low prior knowledge or aptitude in particular content areas.

A growing concern in measuring the effect of CAI on learning, whether multimedia or first generation programming is measuring new learning in old ways. Najjar (1996) points out that if information is presented using new media, then testing impact should be conducted using that same media. . In other words, if a medium is used to facilitate learning (a computer simulation for example), the same medium should be used to facilitate testing.

Context

In early 1996 a two-stage quantitative and qualitative evaluation of a computer-assisted reading program began at Alberta Vocational College, Calgary, Alberta.

The City of Calgary
Located in south central Alberta at the foot of the Rocky Mountains, Calgary is Alberta's largest city by area and home to approximately 750,000 people. Renowned for the Calgary Stampede, and host of the 1988 Winter Olympics, Calgary serves a large agricultural community and several bedroom communities as well, for a trading area of nearly two million people. English is the predominant language spoken, although Chinese, German, and French are not uncommon.

Leading telecommunications, oil, environmental sciences, consulting, engineering, food processing, finance, and advanced technology industries are based in Calgary. The City has the highest concentration of employees in science, engineering and mathematics of all Canadian cities. With a median age of thirty-three years, Calgarians regard their City as young, prosperous and progressive.

Alberta Vocational College - Calgary
Alberta Vocational College - Calgary is a post-secondary institution providing adult academic upgrading, English as a Second Language, and career-entry programs of one year or less in health, business, and service industries.

AVC - Calgary has existed for over 30 years and has developed relevant ways to make learning a lifelong experience. This expertise enables the College to successfully deliver responsive programming to meet the needs of adult learners and the demands of employment environments. By using competency based curricula, prior learning experience can be recognized and assessed, individual learning instruction plans can be developed, and training for business can be customized.

The Basic Education Alternative Delivery (BEAD)
The Basic Education Alternative Delivery (BEAD) program uses alternative delivery strategies to offer individualized education programs to adult learners. Students may be full-time or part-time in basic mathematics, English and reading. The BEAD program

features continuous enrollment, flexible attendance, individualized programs, self-paced study and computer-assisted instruction.

Students are able to register in one of a variety of locations, including the main AVC campus, urban community campuses, or several rural community campuses throughout southern Alberta. Adult Basic Education Level 1 (ABL) students are deemed to be below Grade 4 reading level, Level 2 (ABE) students at the Grade 4 to 6 range, and Level 3 students at the Grade 7 to 9 reading range.

ABE classes are available to students Monday through Thursday, 9:00 a.m. to 2:00 p.m., September to May. Student to instructor ratio is approximately 18 to one.

Full-time ABL students can attend classes for 24 hours a week; part-time students for nine hours a week. Classes are available Monday to Thursday, September to May. The student instructor ratio in ABL is ten to one with additional support from volunteer tutors.

English as a Second Language (ESL)

The English as a Second Language programs at AVC - Calgary are split into two levels--beginning and intermediate. Both programs have a comprehensive focus on building students' listening, speaking, pronunciation, grammar, reading and writing skills. Teachers use innovative teaching methods and a variety of books, films and tapes to ensure that students learn rapidly and effectively. Class size is limited in order to give students individualized attention from the instructor. New students are given placement tests and enrolled at level commensurate with their English proficiency.

The full-time ESL program provides intensive English language instruction. Students attend classes Monday, Tuesday, Thursday and Friday from 9:00 a.m. to 2:30 p.m. and from 9:00 a.m. to 12:15 p.m. on Wednesdays. Course terms are ten weeks long and run consecutively throughout the year (5 ten-week terms), including the summer. There is testing and placement in new levels each term.

The Intermediate Plus ESL program is intended to provide additional training for ESL students who exceed beginning levels and/or have high intermediate or advanced level ability in reading comprehension, but insufficient language skill to find employment or meet academic upgrading goals. This program has four fundamental courses: Conversation, Communicative Grammar, Reading and Discussion, and Improving Writing. Each course runs 4.5 hours a week on Mondays, Tuesdays, Thursdays and Fridays. Two

option courses, Oral Skills Development and Introduction to Computers, are offered on Wednesdays.

Method

The evaluation design was quasi experimental, non-randomized, pretest-posttest, control group. While attempts to match control and treatment groups were exercised, random assignment of groups was not possible. The independent variable was the CAI program (Autoskill and/or PLATO). The dependent variables were reading performance in sightword recognition, decoding skill, and comprehension.

Treatment

The **Autoskill Reading Program** is a computerized skills-oriented learning resource aimed at promoting the acquisition of skills needed for the mastery of reading.

The **PLATO** (Basic Literacy Skills Reading-Canadian Edition) is a modularized computer-assisted instruction program designed to meet individual learner needs, and to match objectives of learners' educational or training programs.

Effects of the treatment and a moderator variable (entry-level reading skill) were examined. Groups were combined and grouped according to treatment and control. Analysis of groups included:
1) Stage One (February 1996 to February 1997) ABL, ESL, and ABE students;
2) Stage Two (September 1996 to June 1997) ABL, ESL, and ABE students; and
3) Stage One and Two combined ABL, ESL, and ABE students.

Groups were further categorized into low, medium, and high reading ability according to pretest results.

Reading Skill Assessments were conducted using the Bader Inventory, Yopp-Singer Test, and Woodcock-Johnson standardized reading inventory. Data were collected three times (pretest, posttest, 6-month follow-up retention test).

Qualitative data were collected in Stage One and Stage Two from students and instructors. Evaluators also observed students using the computer programs. Both survey and interview techniques were used to collect data immediately following the treatment.

Evaluation Design

A pre-test, post-test design was used for the evaluation. Samples of students were selected according to geographic proximity to certain training sites (South, West, and Central). Control and treatment groups were divided according to training location. A post-test was administered to students immediately following the completion of the student's program. A retention test was administered six months after completion of the program. In addition, students were given surveys to complete and were interviewed by the evaluators during focus group sessions. Instructors kept logs and participated in interviews with the evaluators.

Subject Assignment	Pretest	Treatment Period	Posttest1	Posttest2
Not Random	O_1	X_1	O_2	O_3
Not Random	O_1	No X	O_2	O_3

A total of 167 students were initially registered in the study (84 Stage One, 83 Stage Two). A total of 127 students completed the study.

Stage One Participant Assignment

Group	Duration	Control Group		Treatment Group	
		Registered	Completed	Registered	Completed
ABE	15 weeks	16	16	17	13
ESL	10 weeks	16	9	17	14
ABL	20 weeks	9	5	9	4

Stage One Treatment Schedule (Autoskill Program)

Treatment Group	Duration	Hours/Day	Total Time on Autoskill
ABE	15 weeks	1-1.5 hr/day	12 hrs. (maximum)
ESL	10 weeks	1 hr/day for 5 days	50 hrs.
ABL	20 weeks	2 hrs./day for 4 days	160 hrs.

Changes to treatment and testing tools were made in Stage Two (September 1996 to June 1997) of the study. The PLATO computer-assisted reading software replaced Autoskill as the intervention for ABE and ESL students. The Woodcock-Johnson standardized reading inventory replaced the Bader Reading Inventory and Yopp-Singer Test.

Stage Two Participant Assignment

Group	Duration	Control Group		Treatment Group	
		Registered	Completed	Registered	Completed
ABE	15 weeks	16	12	17	13
ESL	10 weeks	15	11	15	14
ABL	20 weeks	9	8	11	8

Stage Two Treatment Schedule (Autoskill/PLATO Programs)

Treatment Group	Duration	Hours/Week	Total Time on Computer
ABE	15 weeks	Approx 1 hr/week	2-12 hrs.
ESL	10 weeks	2 hr/week	20 hrs.
ABL	12-13 weeks	1 hrs/day for 4 days	48 hrs
ABL (part time) N=2	15 weeks	1 hr/week	15 hrs.

Results

Results from this study were similar to many other control studies of computer-assisted instruction. A modest to small treatment effect was observed for some variables, but for the most part, no significant differences were observed between the reading performance of students receiving computer-assisted instruction and those receiving the conventional program of studies at AVC - Calgary. Similar to other studies of this type, qualitative results from the AVC study suggest that students enjoy working with computers and, in many instances, appear more highly motivated to complete their academic tasks.

Computer Effect

While this study reveals few significant differences between the reading performance of students receiving computer-assisted instruction and those receiving the conventional program of studies, statistical results point toward a gain in reading performance by some groups of students whose program included computer-assisted instruction.

Stage One ABE treatment students appeared to do a little better on sightwords than the students in the control group. Both Stage One and Two ABE treatment students showed greater improvement in decoding skills than did the control students. However, on the variable comprehension, ABE treatment students did not do as well as ABE control students.

The CAI treatment Autoskill appeared to have some positive effect on decoding skills for Stage One ESL students. PLATO appeared to enhance Stage Two ESL students' recognition of sightwords and reading comprehension.

Autoskill, used in Stage One treatment in ABL groups positively effected all three variables. During Stage Two, only sight words and comprehension variables were positively impacted for ABL students.

It must be noted that positive impacts were not statistically significant. The statistics indicate a possible trend. These trends may suggest that a more extensive exposure to the treatment may produce a greater impact on some students groups.

Results of this study also suggest that ABL and low initial entry level readers appear to make greatest gains when using CAI programs. This trend may become more significant with increased concentration and sustained used of CAI with these students. High entry level readers did not gain significantly from the versions of Autoskill or PLATO used in this study.

Course Completion

While motivation across groups to use the computer was moderate to high, there appears to be no appreciable difference in the rate of course completions associated with computer use.

Integration of CAI

Integration of CAI with conventional face to face instruction with ABE and ABL was higher in Stage One than in Stage Two. Integration of CAI into the ESL program remained about the same over the two stages. As might be expected, where CAI was more fully integrated into instruction, it had a stronger positive effect on student performance, which may suggest that a certain “critical time mass” is required for CAI to be effective.

Student Satisfaction

With the exception of the Autoskill experience for Stage One ABE students, all students in this study reported enjoying their CAI experience. They believed they received some benefit from using the computer. It is interesting to note that ESL students regarded the computer as part of the course content. In contrast, both ABE and ABL groups reported wanting to "learn" the computer as tool, separate from course content.

Instructor Satisfaction

Before the study began, instructors received varying amounts of orientation and training on Autoskill. Their satisfaction with the training was mixed, however. Some said training was insufficient; others reported that only experience using Autoskill sufficiently prepared them to teach it. Instructors were very willing to explore CAI and were supportive and cooperative throughout the study. Overall, their satisfaction with CAI was moderate to high.

Challenges to Implementing Controlled Studies

Implementing a comprehensive evaluation study in a fully functioning college is a challenge, especially when evaluations involve elements of control. Creating equivalent treatment and control groups, as well as student attrition posed complications and compromises to the study. Results should therefore be considered within these limitations that point mainly to factors confounding experimental design studies: sample selection and assignment, treatment and control group matching, changes in test instruments, and subject attrition.

Recommendations

The following are some suggestions for the continued use of CAI with adult audiences at AVC - Calgary:

1. **Continued Use of CAI**
   CAI should continue to be used with low and mid-range reading level audiences. Autoskill can be expected to have its best effect with low level readers.

2. **Strategically Use CAI**
   Where used, CAI should be applied in a consistent and concentrated fashion. It should be used strategically and not as a blanket solution for all students.

3. **Use CAI to Reinforce Computer Skills**
   There are some value-added gains in using CAI with students. Additional time on computers reinforces previously and newly learned computer skills such as keyboarding and use of the mouse. In addition, some benefits can be attributed to the computer use in improving student confidence and self-esteem.

4. **Update PLATO**
   PLATO reading software should be updated. The current version at AVC - Calgary cannot take advantage of Windows features on 486 + computers.

5. **Continue to Evaluate Reading Software**
   AVC - Calgary should continue to evaluate reading software, especially those programs which have extensive adult content and approaches to interpret users' intentions, and stimulate mental associations, or, are rich in information resource capabilities.

6. **Continue to Evaluate CAI Use**
   AVC - Calgary should continue to monitor and evaluate the use of CAI with adult learners. Not all learners appear to equally benefit from CAI. Therefore, it is especially important to better understand which combinations of teaching style, learning style, student entry-level ability, and CAI are best suited to enhancing the academic performance of adult students.

Conclusions

Like many studies that have preceded it, this evaluation confirms that computer-assisted instruction is neither superior nor inferior to conventional instruction. Where CAI can be used to improve efficiencies it should be considered.

The type of software chosen as the independent variable for this study appears to be most beneficial to those learners whose entry-level reading skills are low. If CAI is to be chosen to assist the reading of moderate to high-level readers, other software should be selected.

We know that computer assisted instruction can be as effective as conventional instruction. Therefore, those providing instruction to adult learners should not ignore the potential uses of CAI. The question that continues to merit further study is not whether computers are useful in adult instructional settings, but rather what instructional

techniques work best with adult learners. Then, can we develop computer models to effectively facilitate these instructional techniques? New advances in multi-media appear to offer some hope.

APPENDIX A.
Literature Review

INTRODUCTION

Reading and writing are important skills and are directly linked to the social and economic well-being of Canadians. According to the Organization for Economic Co-operation and Development (OECD) and Statistics Canada (1995), Canada and six other industrialized nations (United States, Germany, the Netherlands, Poland, Sweden, and Switzerland) have inadequate levels of literacy among a broad section of the population. Low literacy levels potentially threaten the economic strength and the social cohesion of a nation (Statistics Canada, 1996). Therefore, it is imperative that literacy levels are raised and that all levels of education address the literacy issue.

Traditionally, western cultures have relied on schools or other forms of formalized instruction to teach reading and writing, where for the most part, instruction materials are print-based and lessons are delivered by a teacher to a group of students. For some 200 years the most dominant technologies (teaching and learning tools) in education have been paper, pencils, desks, and blackboards. However, challenges to tradition have been plentiful. The most pressing pressures for change has been stimulated by advances in computers and information technology. From the development of computer-assisted instruction (CAI) on large mainframe computers in the early 1960's, CAI has been heralded as one of the greatest innovations in education. Indeed, the integration of computer technology has been of interest to administrators, researchers and practitioners since the personal computer became a viable educational tool in the early 1970's.

Many arguments are posed advocating the use of technology in instruction (Hawkridge Jaworski, & McMahon, 1990). The pedagogic argument promotes technology as a teaching tool, believed to improve student learning. It is the pedagogic argument that is still under considerable debate (Clark, 1994; Kozma, 1994). What follows is a synthesis of the literature addressing the relationship of modern technology (mostly computer technology) to teaching and learning generally, and teaching of literacy skills (reading and writing) to adults, specifically.

TECHNOLOGY USE IN INSTRUCTION

In the past few decades (1975-1995) there have been hundreds, if not thousands, of studies conducted in an attempt to clarify the relationship between technology and learning, more specifically the relationship between the use of technology and 1) performance, 2) attitudes/motivation, and 3) efficiency/cost effectiveness. Several of these studies were school-based.

The more publicized (cited often) have reported no significant difference to modest gains in student performance where control has been introduced for instructional method. Some of the more recent and commonly cited examples include: Johnson, Cox & Watson (1994), a British study conducted with 2300 pupils from 87 classrooms in primary and secondary schools reported an overall effect size of .11 standard deviation units in favour of technology over traditional instruction; Khalili & Shashaani (1994) an American meta-analysis which correlated the results of 36 other studies from elementary school to college reported an overall effect size of .38 standard deviation units in favour of technology over traditional instruction; Metropolitan Educational Research Consortium (1993), another American meta-analysis of 184 studies of CAI, CMI, CEI with a reported overall effect size of .32 standard deviation units, also in favour of technology over traditional instruction; and Kulik, Chen-Lin, and Kulik's (1987) meta-analysis of 200 studies, 74 of which were conducted in American schools. The Kuliks reported an overall effect size of .31 standard deviation units in favour of technology over traditional instruction. Their study went on to report a 32% reduction in instructional time and an increase in positive attitude toward learning/instruction.

Like the Kulik study, other reports indicate that CAI can be a factor in improved attitudes/motivation and efficiency/cost effectiveness. For example, Darter and Phelps (1990) review of the literature on the use of the computer in teaching reading found that CAI has had a positive effect on student and teacher attitudes and motivation, saving teachers' time, savings of student' learning time and opportunities for increased practice and re-teaching. It did not, however, find advantage in using CAI to increase student achievement since scores on post-tests were no better than those which involved only traditional methods. A more recent meta-analysis of twenty-one studies by Rachal (1995) concludes while the majority of the findings indicated no significant difference occurring in student achievement, other benefits were reported: faster rates of learning, immediate feedback, reduced

attrition, increased student self-confidence, and increased privacy. However, these findings were reported as researchers' perceptions rather than empirically derived findings.

Although few if any explanations are offered, many reports suggest that CAI has a particularly positive influence on achievement, attitude, and motivation of special audiences. For deaf children, gains have been reported in reading and writing new words and sentences (Prinz, 1991; Thompson, 1990). Incarcerated adult males benefited from CAI, posting significant pre-test to post-test gains (Spivey, 1992). Thompson (1990) study indicated that CAI appeared to work more effectively for slower, disadvantaged, and below-grade-level readers than for average or above-average readers.

On the other hand, a number of researchers suggest that the literature supporting the use of CAI is at best inconclusive and at worst flawed. Olson & Krendl (1990) report that many studies suggest positive outcomes (improved achievement, lower absenteeism, higher self-esteem, better attitude toward school) resulting from computer use, while their meta-analysis concluded that most of the studies included flaws in the design, measurement and control of critical factors associated with the learning environment. Another meta-analysis of 63 studies (McNeil & Nelson, 1991) investigated cognitive achievement effects following interactive video (IV) instruction. While they felt the effect was similar to that of computer-assisted instruction, they reported that generalizations were impossible due to complex interrelationships among compatible variables and instructional conditions. Others (Darter & Phelps, 1990; Feldmann & Fish, 1991) report no positive effect from using CAI to increase student achievement. Scores on post-tests were no better than those, which involved only traditional methods.

CAI Studies with Adult Reading Populations

Few CAI studies have concentrated on adult subjects. Those that have, report mixed results. As expected, rigorous research studies of the influence of CAI on Adult reading populations are extremely limited. Often, those that do appear tend to be evaluations with little generalizability beyond the specific setting and activities of the research. Therefore, a few upper-level high school reports are added to this review.

A recent meta-analysis by Rachal (1995), examined the effectiveness of computer-assisted instruction (CAI) on the teaching of reading at adult basic and secondary

education levels. This meta-analysis included a number of quasi-experimental studies comparing experimental (CAI) groups to groups using more traditional instructional approaches. Of the twenty-one studies examined in this meta-analysis, variation was reported in their designs, objectives, settings, software, skills examined, and conclusions. While the majority of the findings indicated no significant difference occurring in student achievement, five studies reported improvement in achievement scores for CAI over traditional reading approaches. In addition, other benefits were reported: faster rates of learning, immediate feedback, reduced attrition, increased student self-confidence, and increased privacy. These findings were reported as researchers' perceptions rather than empirically derived findings. Similarly, Garrett (1995) reports mixed results of CAI effectiveness in college to improve academic programs.

The Feldmann & Fish (1991) study has indicated that the use of computer-mediated reading supports did not improve high school students' reading comprehension scores. McLaughlin (1986) says CAI does not improve vocabulary skills, either. The study involving one control group and two experimental groups of college students, one receiving traditional instruction and individualized, in-class, computer-assisted instruction, the other receiving traditional instruction in class and computer-assisted instruction in a lab facility. The results were that no improvement in vocabulary skills between groups was shown, nor did one experimental group out-performed the other.

In contrast, and reporting more qualified results, Weiss (1994) has suggested that readers with access to computer-mediated reading supports score higher on recall tasks. Findings of this study suggest that vocabulary knowledge is the primary contributor to reading comprehension, and that verb conjugation and background information played an insignificant role in enhancing readers' comprehension. The computer might provide unique opportunities to manage readers' interaction with the text during independent reading. An issue emerging from this study, and one to which Weiss advocates further research is the degree to which the reader of the computer controls the assistance provided by the computer.

Other reports provide more tentative conclusions about CAI effectiveness. Thompson (1990) concluded that CAI provided only tentative conclusions about its effectiveness in relation to reading. As already mentioned, this study indicated that CAI appeared to work more effectively for slower, disadvantaged, and below-grade-level readers than for average or above-average readers. Supporting these

conclusions, Tzung-yu (1993) maintains that while Iowa State University students were more interactive with, and positive toward, computers, that computers help monitor successful learning, and encourage groups to spend more time on task, more studies are needed in different instructional situations and subject areas to confirm the use of computer-assisted instruction over traditional print in reading instruction.

Many studies advocate CAI as an adjunct, not a replacement for traditional approaches to teaching and learning. A Canadian study of computer assisted instruction for adults indicated that gains were made and students felt more confident in their abilities as students. Also, they wanted more instructor input. The study concluded that computer assisted learning systems could serve as successful adjuncts to traditional instructional models (Moore, 1993). Garza & Gibbs (1994) later supported this position by suggesting that most successful programs use a whole-language approach employing computer-assisted instruction, study skills, and method evaluation. The same is recommended school-based audiences. Components of language experience, whole language, and computer-assisted instruction are most optimally incorporated into the core reading program (VanProoyen & Clouse, 1994).

With most instructional materials and approaches, quality is an issue. CAI appears to be no exception. Ertmer, Evenbeck, Cennamo, & Lehman, (1994) have found no direct relationship between time-on-task and levels of confidence suggesting that "quality " rather than "quantity" of computer experience may be most critical. They indicate the importance of placing the learner in an environment, which provides acceptable means for voicing frustration and for obtaining encouraging feedback from the instruction regarding one's developing skills.

Others would suggest that regardless of the direct impact of CAI on achievement, CAI and computers offer some definite advantages to the instructor and the learner. An Australian computer-assisted language learning (CALL) project (McCarthy, 1994) found specific advantages in seven areas: organisation of materials; display of items; volume of material and random presentation; feedback, scoring and record-keeping; focused tutorial assistance; graphics and animation; and cognitive direction.

Also, gender may be an issue in CAI. While much of the gender literature in CAI has focuses on male and female access and use of computers (Shashaani, 1994;

Canada & Brusca, 1991), the following is somewhat curious. In many cases CAI requires students to follow directions precisely and independently. One important aspect of this issue is understanding what types of individuals attend to and follow directions. This study indicated that females with a low computer self-efficacy followed more directions that those with a high self-efficacy. Those males with a low computer self-efficacy followed fewer directions than those with a high self-efficacy. An alternative is to provide exercises to increase computer self-efficacy for males. Those could include exercises, which enable the learner to gain confidence in manipulating the computer. These exercises could be provided prior to the CAI or better, embedded in the instruction itself. (Carlson & Grabowski, 1992).

Many support the continued use and exploration of the effectiveness of computer-assisted instruction (Johnson, Cox and Watson, 1994; MERC, 1993; Khalili and Shashaani, 1994; Kulik, Chen-Lin, and Kulik, 1987). In particular calls have been made for further investigation into the use of computers in language learning because of the capacity of the computer to offer interactive learning, and to handle a wider range of activities than other educational aids (Kennedy, 1989).

Second and Third Generation CAI

With the advent of increased computer power and swift and accessible telecommunications, development of CAI has increasingly adopted multimedia approaches to delivery. Multimedia software incorporates text, graphics, animation, pictures, video, and sound to present information. In the literature these new learning environments are being called “second generation CAI”. First generation CAI is defined by the limitations of the medium, primarily forcing learners to engage in simple learning tasks. Second generation CAI increases in complexity of design allowing learners to engage in complex processing, inference making, semantic elaboration and several means of monitoring, retrieval and feedback A third generation of CAI is emerging which offers assistance to students through guided constructive approaches to learning (Goodfellow, 1995).

Research results surrounding this medium are few. Early indications are that learners are better able to acquire vocabulary and improve comprehension, primarily due to the ability of these new programs to assist the learner in making various associations in more realistic and varied contexts (Chun and Plass, 1996a; Chun and Plass, 1996b; Goodfellow, 1995; McBride and Seago, 1996). Also, this new medium is reported to improve student attitude toward subject material and

learning in general (Brett, 1996). Another encouraging feature of multimedia being reported is that various media appear to be successful in encouraging learners to take more responsibility for their own learning (McBride and Seago, 1996).

While we will witness an increase in the use of multimedia in all aspects of education and training, measurement of its effect on learning will be even more complex and controversial than with first generation CAI. As Najjar (1996, p. 129) suggests, people tend to share a common assumption that multimedia information helps people learn, an assumption "based more on personal opinion than on scientifically-based fact." He goes on to say that:

> specific situations in which multimedia information may help people to learn include (a) when the media encourage dual coding of information, (b) when the media support one another, and (c) when the media are presented to learners with low prior knowledge or aptitude in the domain being learned.

A growing concern in the measurement of effect of CAI on learning, whether multimedia or first generation programming is the issue of measuring learning differently. As Najjar (1996) points out, if we present information using the new media, should we not test using the same media?

CONCLUSION

Early beginnings in CAI were difficult. Usually it meant having to invest over a million dollars in hardware and software (Paramskas, 1993). However, in the past decade there have many changes in the evolution of computer-assisted learning (CALL). Some of these changes include the development of multimedia capabilities, colour, animation, and technical improvement of audio and video quality; availability of databases, better fit between computer "tools" and instruction; emphasis on grammar, vocabulary, and reading to support and enable instruction rather than as the content of instruction; improved techniques for drills and tutorials; and packaging of instruction (Jamieson, 1994). More importantly, over the years, computer capacity and power have vastly increased, while costs have remained the same or been reduced.

No significant difference is significant. The literature indicates that for many teaching and learning situations, computer-assisted instruction is as effective as human instruction. Most reports show both student attitude and motivation increases when technology is used to assist instruction. However, there are some inherent complexities in determining the effect of computer-assisted instruction on achievement. Factors such as teachers' and students' attitudes, extent of integration in the curriculum, user interface with the hardware and software, may determine the impact of technology on achievement no less than the technology itself. As Clark (1983) pointed out over a decade ago, research on the influence of media on learning is too often flawed by undefined treatment, treatment too briefly applied, and the lack of statistical controls needed to attribute the observed effect to any cause.

But, student achievement is not the only reason to have teachers and students use technology. Our review of studies tell us that when teachers change their teaching methods and use technology well, we can expect more positive results, not only in improved scores, but in students' ability to problem solve, communicate, and work as a team. This is particularly evident when students are asked to take more responsibility for their own learning. It is not so much "do computers and computer-assisted instruction have a positive influence on instruction and learning", but rather, "it depends." Therefore the questions we may need to ask are how are computers and CAI "best" used to improve learning and teaching, a question of evaluation rather than of generalizable research.

As the number of older students enrolled at post-secondary institutions increases, it becomes important and relevant to continue researching and evaluating computer-assisted instruction as it relates to reading and adult education, particularly in a controlled environment. This is compounded by increasing attention being given to multimedia and the many public assumptions of its positive effects on learning.

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