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An evaluation of 15 studies concerning the effectiveness of tutorial CAI

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Abstract

Increased use of the computer in business, in the classroom, and in the home has become apparent in recent years. Especially, the amount of computers in classrooms has been increasing rapidly in the last several years. According to Tolman and Allred (1991), the number of microcomputers and terminals in U.S. schools was estimated to be between 200,000 and 300,000 in 1982. In 1989, the number had increased to approximately 2.4 million. According to U.S. government statistics, the number of computers in homes is elevating. At the beginning of the 1980s, there were fewer than one million, but by the end of the decade, the number had grown to over 20 million (Blank and Berlin, 1991). With the increasing number of computers in schools and at home, the opportunity to use Computer-Assisted Instruction (CAI) in educational areas is also increasing.

An Evaluation of 15 Studies Concerning the Effectiveness of Tutorial CAI

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CHAPTER I

INTRODUCTION

Introduction to the Problem

Increased use of the computer in business, in the classroom, and in the home has become apparent in recent years. Especially, the amount of computers in classrooms has been increasing rapidly in the last several years. According to Tolman and Allred (1991), the number of microcomputers and terminals in U.S. schools was estimated to be between 200,000 and 300,000 in 1982. In 1989, the number had increased to approximately 2.4 million. According to U.S. government statistics, the number of computers in homes is elevating. At the beginning of the 1980s, there were fewer than one million, but by the end of the decade, the number had grown to over 20 million (Blank and Berlin, 1991). With the increasing number of computers in schools and at home, the opportunity to use Computer-Assisted Instruction (CAI) in educational areas is also increasing.

Computer-Assisted Instruction includes five major types of CAI programs: (1) Drill and Practice, (2)

Simulations, (3) Games, (4) Tests, and (5) Tutorials. Blank and Berlin (1991) claimed that currently learners can choose from over 10,000 programs, covering almost every subject imaginable. Medical students are diagnosing illnesses of simulated patients. Factory workers are getting oriented to their jobs before entering the factory. Fifth graders are developing thinking skills, and kindergartners are learning the alphabet (Steinberg, 1991).

Kulik et al. (1983) have pointed out that researchers believed that CAI would bring great benefits to students and teachers. Among the benefits expected for learners were better, more comfortable, and faster learning, since students would learn at their own pace and at their own convenience; have opportunities to work with vastly richer materials and more sophisticated problems; use personalized tutoring; and experience automatic measurement of progress. Benefits for teachers would include less drudgery and repetition, greater ease in updating instructional materials, more accurate appraisal and documentation of student progress, and more time for meaningful contact with learners.

However, some educators are skeptical about using tutorial CAI with learners. Merrill (1988) has indicated that a tutorial is not a good teaching strategy because it is difficult via a tutorial to teach real world procedures like operating a piece of machinery, trouble shooting a circuit, drawing a circuit diagram or designing a house. Orr (1990) mentioned that tutorials for teaching the operation of word processing software have come onto the market in recent years, and because the subject matter being taught utilizes the computer, it seems logical that a computer-assisted tutorial would be an effective instructional tool. But empirical data are not available that evaluates the effectiveness of this approach when compared to other word processing instructional methods. In addition, Allen and Carter (1988) have noted that there is one way for increasing the flexibility of tutorials, that is to provide learners with more control over organization, content, and instructional strategies. On the other hand, many students do not know how to make effective use of such a variety of learner control options provided by the tutorial. Isaacs (1990) pointed out that tutorials are

not good for teaching students the more complex learning styles such as deep-level processing. Therefore, understanding about tutorial CAI becomes important if we would like to make improvements in learning via the computer.

Statement of Purpose

The purpose of this paper is to evaluate the literature concerning the effectiveness of traditional tutorial CAI in instructing learners.

Research Questions

The most important questions that I want to answer are:

1. What is computer-assisted instruction?
2. What is tutorial computer-assisted instruction?
3. Is tutorial computer-assisted instruction effective for learning?

Definition of Terms

CAI

Computer-assisted instruction (CAI) is defined in this paper as "computer applications applied to traditional teaching methods such as drill, tutorial, demonstration, simulation and instructional games" (Coburn and others, 1982, p. 253)

Tutorial CAI

Tutorial CAI is defined in this paper as "a type of educational software in which the computer serves as a private teacher. Usually it is originally developed by instructional design principles and its common characteristics include (1) an ordered sequence of instruction, (2) the presentation of information in small increments, (3) active student responses, (4) a narrow range of possible answers, and (5) provisions to reinforce correct responses while informing the learner about his/her progress." (Price, 1991; Brownell, 1992; Kemp, 1989; Miller, 1987)

CHAPTER II

REVIEW OF THE LITERATURE

In an attempt to build a general knowledge of computer-assisted instruction (CAI) for this paper, the review of literature is divided into three parts. It begins with an introduction of CAI which defines CAI and it's effectiveness. The second section focus more specifically on the definition and primary uses of tutorial CAI. Finally, a comparison of the findings of fifteen research studies concerning tutorial CAI are presented.

Computer-Assisted Instruction (CAI)

Computer-assisted instruction has been used for more than a quarter of a century. People everywhere are studying through CAI lessons today. (Steinberg, 1991). The term computer-assisted instruction has been defined differently by different researchers. It is difficult to define CAI precisely because it is used in many ways.

Defining CAI

Brownell (1992) defined CAI as: "Any use of computers to provide instruction to students; that is, any use of the computer where students and computers come together for an educational purpose and learning occurs."

Tolman (1991) suggested that CAI should give some control to the student. Student interacting with computers, with information and/or with stimulus material presented on monitors. Usually the student receives feedback from the computer, which maintains some degree of control over the sequencing of material." (p. 10)

Coburn et al. (1982) specifically defined CAI as: "Computer applications applied to traditional teaching methods such as drill, tutorial, demonstration, simulation and instructional games" (p. 253)

According to Steinberg (1991), there is no established definition for CAI. Computers can assist instruction in many ways. Computer-presented instruction embraces a wide range of techniques and can vary in complexity from simple drills to decision making tasks. Drill and practice programs about foreign

language can help students practice vocabulary. As a student progresses, the program can retire items a student has learned and repeat items missed. Simulations allow students to make life- threatening decisions and observe their consequences without danger to themselves or others. Communications capabilities of computer networks make it possible for students in different locations, even in different countries, to engage in cooperative science experiments. Some definitions of CAI encompass all of these applications of computers to instruction; some include only computer-presented applications.

In this paper, computer-assisted instruction (CAI) is defined as "computer applications applied to traditional teaching methods such as drill, tutorial, demonstration, simulation and instructional games." (Coburn and others, 1982, p. 253)

Effectiveness of CAI

In the last twenty years a number of integrative analyses of CAI's effectiveness have been done. Basically, there are two primary types of studies: narrative and meta-analytic. In narrative reviews,

studies are counted as either positive, negative, or nonsignificant. Meta-analytic reviews use statistical analysis of a collection of results from individual studies in order to synthesize study findings.

According to Dunkel (1990), both the narrative and meta-analytic reviews identify several positive finding concerning the effectiveness of CAI: (a) reduction in learning time due to CAI; (b) attitudes toward using computers, the subject matter or school learning, and self; and (c) the effect of computer use in specific content areas. In his narrative review, Orlansky (1983) found that using computer-based treatments resulted in a reduction in learning time by one-third. In their meta-analysis of college-level computer-based education (CBE) studies, Kulik et al. (1986) found a time-savings of 39% with CAI over more traditional instructional means. This substantiates earlier findings by Hughes (1977) where he found that the CAI students spent 135 minutes on instruction and study, compared to the conventionally-taught students who required 220 minutes to achieve the same level of content mastery. Kulik and Schwalb (1986) meta-analyzed the impact of CAI on adult learning and detected that in 13 studies comparing

instructional time for students in CAI and conventional environments, CAI students required less than three-fourths as much instructional time to acquire content taught as did students who were taught with conventional methods.

In addition, computer-assisted instruction is considered by educators as a useful tool for individualizing instruction. Fifteen prominent educators were asked to share their "wish lists" for education. Several of these contributors claimed that the computers would help them be more effective in meeting the students' needs individually (Tolman, 1991).

It seems that many research studies have been performed comparing using CAI to teach something is better than using traditional methods.

Tutorial

Tutorial is a type of CAI program. There are five major types of CAI programs: Drill and Practice, Simulations, Games, Tests, and Tutorials. This paper will emphasize the tutorial type of CAI (not including intelligent CAI).

Defining Tutorial

Price (1991) defined tutorial as: "The mode of CAI in which the computer serves as a private teacher. Tutorials may be primary instruction rather than a follow up to instruction presented away from the computer." (p. 383)

Brownell (1992) explains tutorial as a type of educational software that teaches the student by engaging her in a dialogue related to the material being taught.

Kemp (1989) further defined a tutorial as "a computer program that presents information followed by a question or problem, then based on user's answer, the next block of instruction is presented or remedial instruction is provided." (p. 385)

Miller (1987) specifically defined tutorial software as a program that "Usually attempts to introduce new information and concepts. It often uses instructional design principles originally developed for programmed instruction and its common characteristics include (1) an ordered sequence of instruction, (2) the presentation of information in small increments, (3) active student responses, (4) a

narrow range of possible answers, and (5) provisions to reinforce correct responses while informing the learner about his/her progress." (p. 32)

According to the definitions above, the term tutorial means a type of educational software in which the computer serves as a private teacher. Usually it is originally developed using instructional design principles and its common characteristics include (1) an ordered sequence of instruction, (2) the presentation of information in small increments, (3) active student responses, (4) a narrow range of possible answers, and (5) provisions to reinforce correct responses while informing the learner about his/her progress. (Price, 1991; Brownell, 1992; Kemp, 1989; Miller, 1987)

Primary Uses of Tutorial Computer-Assisted Instruction

There are two general forms of tutorial programs, linear and branched. In the linear form of instruction the learner is presented with an instructional sequence consisting of text presentations which are sometimes combined with visuals, questions, and feedback. The

linear programs require all learners to follow the same path regardless of their responses (Price, 1991). The students proceed from the first step to the second and continue until they reach the end of the lesson (Howie, 1989).

Branching programs have several entirely different instructional paths. For example, a learner who misses several questions may be directed by the program into a remedial sequence path that is never seen by other learners. Other programs may provide for options so that learners can choose the portion of the lesson to be worked on. Branching programs may also pretest the learner to see how much of the information to be presented in a given sequence is already known, and then allow him or her to omit such material.(Price, 1991).

Tutorial CAI tries to function like a human tutor providing individualized feedback and to allow the student to work at his/her own pace. It is reasonable that tutorials are expected to be helpful on instruction/learning.

Effectiveness of Tutorial Computer-Assisted Instruction

The effectiveness of tutorial CAI has been studied in a number of areas. This paper reviews 15 studies in the areas of mathematics, biology, chemistry, sociology, psychology, statistics, word processing, sport biomechanics, aircrew training, tennis rules, dietetics education, and basic skill.

Table 1 indicates the authors, publishing year, topics, and results of fifteen of the studies.

TABLE 1
Studies Concerning
the Effectiveness of Tutorial CAI

Note: O=Positive; X=Negative; N=No Different

Researcher	Topic	Result
Guthrie & McPherson (1992)	The efficacy of a customized approach to computer assisted instruction	N
Plomp et al. (1991)	The effectiveness of remedial computer use for mathematics in a university setting (Botswana)	O
Orr (1990)	A comparison of achievement and attitudes of postsecondary students taught by two methods of instruction8 in word processing	N

Collis et al. (1989)	An evaluation of computer-based instruction in statistical techniques for social work students	O
Emerson (1989)	A comparative evaluation of computer based and non-computer based instructional strategies	O
Kerns (1989)	The effectiveness of computer-assisted instruction in teaching tennis rules and strategies	N
Neapolitan (1989)	A test of simple computer-assisted instructional software	O
Wainwright (1989)	The effectiveness of a computer-assisted instruction package in high school chemistry	O
Edwards (1986)	Low-cost avionics simulation for aircrew training	O
Johnson & Churchill (1986)	A comparison of computer based training vs. instructor based training using Microsoft Word	X
Smith et al. (1986)	Production and evaluation of interactive videodisc lessons in laboratory instruction	O

Whiting (1985)	The use of a computer tutorial as a replacement for human tuition in a mastery learning strategy	O
Ybarrondo (1984)	A study of the effectiveness of computer-assisted instruction in the high school biology classroom	N
Saracho (1982)	The effects of a computer-assisted instruction program on basic skills achievement and attitudes toward instruction of Spanish-speaking migrant	O
Schroeder & Kent (1982)	Computer-based instruction in dietetics education	N

Orr (1990) compared the effectiveness of two methods of instruction, using a computer-based tutorial and using a textbook, in word processing. Collis et al. (1988) evaluated the use of computerized tutorial support for elementary statistics instruction in five different education and social work courses. Neapolitan (1989) conducted an experiment using a computer tutorial to test the effectiveness of simple CAI software. Ybarrondo (1984) certified whether or not CAI enhanced the quality of the educational experience and resulted in increased learning. Saracho (1982) investigated the effects of a CAI program on basic skills achievement and attitudes toward instruction of

Spanish-speaking migrant children. Jolicoeur and Berger (1988) measured the effectiveness of eight software programs in teaching fifth graders new fraction concepts and spelling words. Smith et al. (1986) produced and evaluated computer-assisted interactive videodisc lessons in laboratory instruction. Whiting (1985) investigated the use of a computer tutorial as a replacement for human instruction in a mastery learning strategy. Schroeder and Kent (1982) tested the effectiveness of teaching renal diet therapy for kidney patient by two methods, the CBI method and a traditional lecture/laboratory method. Emerson (1988) compared the effectiveness of computer based and non-computer based instructional strategies. The results of these studies will be discussed in the following section.

The findings from these research studies are quite different. Some of them found positive results when comparing
tutorial CAI to traditional instruction; some of them found no significant difference; others found negative results on using tutorial CAI. Table 2 shows the classification of the studies based on the different

results. Nine of the studies found positive results. Five of them found no difference. One of them found negative results.

TABLE 2
The classification
of the 15 studies based on results

Note: O=Positive; X=Negative; N=No Different

Researcher	Topic	Result
Positive Results		
Plomp et al. (1991)	The effectiveness of remedial computer use for mathematics in a university setting (Botswana)	O
Neapolitan (1989)	A test of simple computer-assisted instructional software	O
Wainwright (1989)	The effectiveness of a computer-assisted instruction package in high school chemistry	O
Collis et al. (1989)	An evaluation of computer-based instruction in statistical techniques for social work students	O
Emerson (1989)	A comparative evaluation of computer based and non-computer based instructional strategies	O
Edwards (1986)	Low-cost avionics simulation for aircrew training	O
Smith et al. (1986)	Production and evaluation of interactive videodisc lessons in laboratory instruction	O
Whiting (1985)	The use of a computer tutorial as a replacement for human tuition in a mastery learning strategy	O

Saracho (1982)	The effects of a computer-assisted instruction program on basic skills achievement and attitudes toward instruction of Spanish-speaking migrant	O

No Different Results

Guthrie & McPherson (1992)	The efficacy of a customized approach to computer assisted instruction	N

Orr (1990)	A comparison of achievement and attitudes of postsecondary students taught by two methods of instruction8 in word processing	N
Kerns (1989)	The effectiveness of computer-assisted instruction in teaching tennis rules and strategies	N
Ybarrondo (1984)	A study of the effectiveness of computer-assisted instruction in the high school biology classroom	N
Schroeder & Kent (1982)	Computer-based instruction in dietetics education	N
Negative Results		
Johnson & Churchill (1986)	A comparison of computer based training vs. instructor based training using Microsoft Word	X

Research Literature Concerning the Effectiveness of Tutorial CAI

This narrative review examines 15 studies in the areas of mathematics, biology, chemistry, sociology, psychology, statistics, word processing, sport biomechanics, aircrew training, tennis rules, strategies, dietetics education, and basic skill. It begins by presenting a graphic review of the studies in table form. It then describes the connections between the results. At the beginning the findings of the 15

research is presented. Second, the research methods of the 15 studies are compared. Finally, the variables of the studies (student level and subject area) are compared.

The Findings of 15 Research

Table 3 shows the findings of 15 research studies on the effectiveness of tutorial CAI. All fifteen studies examined users' performance (Guthrie and McPherson, 1992; Plomp et al., 1991; Orr, 1990; Kerns, 1989; Neapolitan, 1989; Wainwright, 1989; Collis et al., 1988; Emerson, 1988; Edwards, 1986; Johnson and Churchill, 1986; Smith et al., 1986; Whiting, 1985; Ybarrondo, 1984; Saracho, 1982; Schroeder and Kent, 1982). Additionally some of the studies examined other characteristics associated with tutorial CAI. Eight of them highlighted the users' attitudes toward tutorial CAI (Guthrie and McPherson, 1992; Plomp et al., 1991; Orr, 1990; Neapolitan, 1989; Collis et al., 1988; Ybarrondo, 1984; Saracho, 1982; Schroeder and Kent, 1982); one of them examined reduction in learning time (Neapolitan, 1989); and one of them identified the cost-effectiveness of tutorial CAI (Edwards, 1986).

TABLE 3
Comparison of
the Research Finding on Effectiveness

Note: O=Positive; X=Negative; N=No Different

Researcher	Performance	Attitude	Time	Cost Effectiveness
Guthrie and McPherson (1992)	N	O		
Plomp et al. (1991)	O	O		
Orr (1990)	N	N		
Kerns (1989	N			
Neapolit (1989)	O	O	X	
Wainwright (1989)	O			
Collis et al. (1988)	O	O		
Emerson (1988)	O			
Edwards (1986)	O			O
Johnson and Churchill (1986)	X			
Smith et al. (1986)	O			
Whiting (1985)	O			
Ybarrondo (1984)	N	O		
Saracho (1982)	O	X		
Schroeder and Kent (1982)	N	O		

Performance: Nine of the 15 studies found that learners who used tutorial CAI had significantly better performance than learners who did not use tutorial CAI (Plomp et al., 1991; Neapolitan, 1989; Wainwright, 1989; Collis et al., 1988; Emerson, 1988; Edwards, 1986; Smith et al., 1986; Whiting, 1985; Saracho, 1982); five studies found no significant differences in learners' performance (Guthrie and McPherson, 1992; Orr, 1990; Kerns, 1989; Ybarrondo, 1984; Schroeder and Kent, 1982); and only one study reported negative effects on performance of learners who used tutorial CAI (Johnson and Churchill, 1986).

Attitudes toward Tutorial CAI: Eight of the 15 studies examined the effects of tutorial CAI on learner attitudes toward the subject material (Guthrie and McPherson, 1992; Plomp et al., 1991; Orr, 1990; Neapolitan, 1989; Collis et al., 1988; Ybarrondo, 1984; Saracho, 1982; Schroeder and Kent, 1982), six reported that learner attitudes toward tutorial were more positive than in the regular classes (Guthrie and McPherson, 1992; Plomp et al., 1991; Neapolitan, 1989; Collis et al., 1988; Ybarrondo, 1984; Schroeder and

Kent, 1982). Only one study researcher detected negative attitude (Saracho, 1982) and one found no difference in the attitudes between tutorial CAI and traditional classes (Orr, 1990).

Reduction in Learning Time: One of 15 studies examined the amount of time necessary for learning material using tutorial CAI (Neapolitan, 1989). The study reported that learners who worked with the tutorial took a mean of six more minutes than those who learned through more traditional means.

Cost-effect of tutorial CAI: One of the 15 studies examined the cost-effectiveness of tutorial CAI (Edwards, 1986). The study reported that experimental training via the microcomputer-based, self-tutorial trainer was fully as effective as aircraft training for the tasks and yielded a cost-benefit ratio of 4.76 to 1 (aircraft training cost versus tutorial CAI trainer cost). These results demonstrate the potential benefit of the experimental trainer to reduce training cost.

The Comparison of the Research Method of the 15 Studies

Table 4 identifies 4 primary types of methods used by the 15 studies: (1) TCAI vs. traditional instruction (TCAI vs TI), used by Kerns (1989), Edwards (1986), Johnson and Churchill (1986), Smith et al. (1986), Whiting (1985), and Schroeder and Kent (1982). (2) TCAI vs. self-paced learning by using materials without traditional instruction (TCAI vs SPL), used by Orr (1990), Neapolitan (1989), and Emerson (1988). (3) combination of TCAI and traditional instruction vs. traditional instruction (TCAI+ TI vs TI), used by Guthrie and McPherson (1992), Plomp et al. (1991), Collis et al. (1988), Ybarrondo (1984), and Saracho (1982). (4) combination of TCAI and traditional instruction vs. combination of supplementation and traditional instruction (TCAI+TI vs S+TI), used by Wainwright (1989).

The term TCAI means tutorial computer-assisted instruction, a type of educational software in which the computer serves as a private teacher; TI means traditional instruction, usually using lecture to deliver information to learners; SPL means self-paced

learning, learning by learners' own pace through printed material or non-print material; S means supplementation, using material to aid the instruction as supplementation.

TABLE 4
Comparison of the Research Method
of the 15 Studies

Note: TI=Traditional Instruction; TCAI=Tutorial CAI
SPL=Self-Paced Learning; S= Supplementation
O=Positive; X=Negative; N=No Different

Researcher	Method	Effect
Guthrie and McPherson (1992)	TCAI+TI vs TI	N
Plomp et al. (1991)	TCAI+TI vs TI	O
Orr (1990)	TCAI vs SPL (Text Book, No Instruction)2	N
Kerns (1989)	TCAI vs TI	N
Neapolitan (1989)	TCAI vs SPL (Reading, No Instruction)	O
Wainwright (1989)	TCAI+TI vs S (Worksheet)+TI	O
Collis et al. (1988)	TCAI+TI vs TI	O
Emerson (1988)	TCAI vs SPL (Programmed Instruction, Electronic Text, Socratic Dialogue, and Printed Reading Assignment)	O

Edwards (1986)	TCAI vs TI	O
Johnson and Churchill (1986)	TCAI vs TI	X
Smith et al. (1986)	TCAI/TCAI+TI vs TI	O
Whiting (1985)	TCAI vs TI	O
Ybarrondo (1984)	TCAI+TI vs TI	N
Saracho (1982)	TCAI+TI vs TI	O
Schroeder and Kent (1982)	TCAI vs TI	N

Table 5 indicates the relationship between the method and effect on learning of the 15 studies. The types of effect divide into three classes: positive, negative, and no difference. The positive effect means that using tutorial CAI has more effectiveness than others on learning. The positive effect means that using tutorial CAI have less effectiveness than others on learning. No difference means that there is no significant difference between using tutorial CAI and other teaching method.

TABLE 5
The Relationship between the Methods
and Effect on Learning

Note: TI=Traditional Instruction; TCAI=Tutorial CAI
SPL=Self-Paced Learning; S= Supplementation

	Effect on Learning			
Method	Positive	Negative	No difference	Total
TCAI vs TI	3	1	2	6
TCAI vs SPL	2	0	1	3
TCAI+TI vs TI	3	0	2	5
TCAI+TI vs S+TI	1	0	0	1

In the six studies using TCAI vs TI method, three of them found positive results (Edwards, 1986; Smith et al., 1986; Whiting, 1985). One of them found negative results (Johnson and churchill, 1986). Two of them found no difference (Kerns, 1989; Schroeder and Kent, 1982). In the three studies using TCAI vs SPL method, two of them found positive results (Neapolitan, 1989; Emerson, 1988). One of them found no difference (Orr, 1990).

In the five studies using TCAI+TI vs TI method, three of them found positive results (Plomp et al., 1991; Collis et al., 1988; Saracho,1982). Two of them

found no difference (Guthrie and McPherson, 1992; Ybarrondo, 1984). The one using TCAI+TI vs S+TI method found positive results (Wainwright, 1989).

The Comparison of the Variables of the 15 Studies

Student Level: Table 6 shows that there are 3 primary types of learner levels within the 15 studies: (1) Student, such as graduate, college, high school, and elementary school students; (2) Non-student, such as pilots; and (3) Combination of student and non-student, like a combination of faculty, staff, and graduate student.

TABLE 6
Comparison of the Variable (Student Level) of the 15 Studies

Note: O=Positive; X=Negative; N=No Different

Researcher	Learner Level	Effect of Tutorial
Guthrie and McPherson (1992)	College	N
Plomp et al. (1991)	College	O
Orr (1990)	College	N

Kerns (1989)	College	N
Neapolitan (1989)	College	O
Wainwright (1989)	High School	O
Collis et al. (1988)	Graduate & College	O
Emerson (1988)	College	O
Edwards (1986)	Pilots	O
Johnson and Churchill (1986)	Faculty, Staff, & Graduate	X
Smith et al. (1986)	College	O
Whiting (1985)	College	O
Ybarrondo (1984)	High School	N
Saracho (1982)	Elementary (3rd-6th grade Spanish-speaking migrant children)	O
Schroeder and Kent (1982)	College	N

Table 7 identifies the relationship between the learner level and the effect on learning of the 15 studies.

TABLE 7
The Relationship Between the Learner Level and Effect on Learning

	Effect on Learning			
Learner Level	Positive	Negative	No Difference	Total
Student				
Graduate & College	6	0	4	10
High School	1	0	1	2
Elementary School	1	0	0	1
Non-student	1	0	0	1
Combination of Student & Non-student	0	1	0	1

According to table 7, ten of the 15 studies are graduate and college level (Guthrie and McPherson, 1992; Plomp et al., 1991; Orr, 1990; Kerns, 1989; Neapolitan, 1989; Collis et al., 1988; Emerson, 1988; Smith et al., 1986; Whiting, 1985; Schroeder and Kent,

1982). Two of them are high school level (Wainwright, 1989; Ybarrondo, 1984). One of them is elementary school level (Saracho, 1982). One is non-student (Edwards, 1986). The last one is the combination of student and non-student (Johnson and Churchill, 1986).

In the 10 studies with graduate to college level student, 6 of them found positive results (Plomp et al., 1991; Neapolitan, 1989; Collis et al., 1988; Emerson, 1988; Smith et al., 1986; Whiting, 1985). Four of them found no difference (Guthrie and McPherson, 1992; Orr, 1990; Kerns, 1989; Schroeder and Kent, 1982). With regard to the two studies with high school student, one of them found positive results (Wainwright, 1989); another 1 found no difference (Ybarrondo, 1984). One of the 15 studies with non-student found positive results (Edwards, 1986). One of them involving both students and non-students found negative results (Johnson and Churchill, 1986).

Subject Area: Table 8 is the comparison of the variable of subject area of the 15 studies.

TABLE 8
Comparison of the Variable (Subject Area)
of the 15 Studies

Note: O=Positive; X=Negative; N=No Different

Researcher	Subject Area	Effect of Tutorial
Guthrie and McPherson (1992)	Sport biomechanics	N
Plomp et al. (1991)	Math & Science	O
Orr (1990)	Word Processing	N
Kerns (1989)	Tennis Rules & Strategies	N
Neapolitan (1989)	Sociology & Psychology	O
Wainwright (1989)	Chemistry	O
Collis et al. (1988)	Statistics	O
Emerson (1988)	Biology	O
Edwards (1986)	Aircrew Training	O
Johnson and Churchill (1986)	Word Processing	X
Smith et al. (1986)	Chemistry	O
Whiting (1985)	Biology	O
Ybarrondo (1984)	Biology	N
Saracho (1982)	Basic Skills	O
Schroeder and Kent (1982)	Dietetics Education	N

There are 5 primary types of subject areas: (1) Science, including mathematics, biology, and chemistry; (2) Social science, including sociology, psychology, and statistics; (3) Skill, including word processing and aircrew training; (4) Health education, including sport biomechanics, tennis rules and strategies, and dietetics education; and (5) Basic skill.

Table 9 indicates that six of the 15 studies were focused on the subject of science (Plomp et al., 1991; Wainwright, 1989; Emerson, 1988; Smith et al., 1986; Whiting, 1985; Ybarrondo, 1984). Two of them examined social science (Neapolitan, 1989; Collis it al. 1988). Three of them discussed manual skills (Orr, 1990; Edwards,1986; Johnson and Churchill, 1986). Three of them were of health education (Guthire and McPherson, 1992; Kerns, 1989; Schroeder and Kent, 1982). One explored basic skills (Saracho, 1982).

TABLE 9
The Relationship
Between the Subject Area and Results

	Result			
Subject area	Positive	Negative	No Difference	Total
Science	5	0	1	6
Social science	2	0	0	2
Skill	1	1	1	3
Health education	0	0	3	3
Basic skill	1	0	0	1

In the 6 studies focused on the subject of science, 5 of them found positive results (Plomp et al., 1991; Wainwright, 1989; Emerson, 1988; Smith et al., 1986; Whiting, 1985). One of them found no difference (Ybarrondo, 1984). In the 2 studies of social science, both of them found positive results (Neapolitan, 1989; Collis et al., 1988). In the 3 studies of skill, 1 positive (Edwards, 1986), 1 negative (Johnson and Churchill, 1986), and 1 no difference result were found (Orr, 1990). The study of basic skill found positive results (Saracho, 1982).

Table 10 indicates the comparisons of the

performances of the 15 researches with their variables.

TABLE 10
Comparisons of
the Research Findings with Variables

Note: O=Positive; X=Negative; N=No Different;
TI=Traditional Instruction; TCAI=Tutorial CAI;
SPL=Self-Paced Learning; S=Supplementation

Researcher	Performance	Instructional Method	Learner Level	Subject Area
Plomp et al. (1991)	O	TCAI+TI vs TI	College	Math & Science
Neapolitan (1989)	O	TCAI vs SPL	College	Sociology & Psychology
Wainwright (1989)	O	TCAI+TI vs S+TI	High	Chemistry
Collis et al. (1988)	O	TCAI+TI vs TI	Graduate & College	Statistics
Emerson (1988)	O	TCAI vs SPL	College	Biology
Edwards (1986)	O	TCAI vs TI	Pilots	Aircrew Training
Smith et al. (1986)	O	TCAI/TCAI+TI vs TI	College	Chemistry
Whiting (1985)	O	TCAI vs TI	College	Biology
Saracho (1982)	O	TCAI+TI vs TI	Elementary	Basic Skills

Guthrie and McPherson (1992)	N	TCAI+TI vs TI	College	Sport Biomechanics
Orr (1990)	N	TCAI vs SPL	College	Word Processing
Kerns (1989)	N	TCAI vs TI	College	Tennis Rules & Strategies
Ybarrondo (1984)	N	TCAI+TI vs TI	High	Biology

Schroeder and Kent (1982)	N	TCAI vs TI	College	Dietetics Education
Johnson and Churchill (1986)	X	TCAI vs TI	Combination of Student & Non-student	Word Processing

Table 11 indicates the comparisons of the learners' attitude toward tutorial of the 15 researches with their variables.

TABLE 11
Comparisons of the Attitude
toward Subject Material with Variables

Note: O=Positive; X=Negative; N=No Different;
TI=Traditional Instruction; TCAI=Tutorial CAI;
SPL=Self-Paced Learning; S=Supplementation

Researcher	Attitude	Instructional Method	Learner Level	Subject Area
Plomp et al. (1991)	O	TCAI+TI vs TI	College	Math & Science
Neapolitan (1989)	O	TCAI vs SPL	College	Sociology & Psychology
Collis et al. (1988)	O	TCAI+TI vs TI	Graduate	Statistics & College
Guthrie & McPherson (1992)	O	TCAI+TI vs TI	College	Sport Biomechanics

Schroeder & Kent (1982)	O	TCAI vs TI	College	Dietetics Education
Orr (1990)	N	TCAI vs SPL	College	Word Processing
Ybarrondo (1984)	N	TCAI+TI vs TI	High	Biology
Saracho (1982)	X	TCAI+TI vs TI	Elementary	Basic Skill

CHAPTER III

CONCLUSIONS

Implication

After reviewing the 15 studies, the following conclusions are reached:

Performance

60.0% of the studies (9 of 15) found that learners who used tutorial CAI had significantly better performance than learners who did not use tutorial CAI (Plomp et al., 1991; Neapolitan, 1989; Wainwright, 1989; Collis et al., 1988; Emerson, 1988; Edwards, 1986; Smith et al., 1986; Whiting, 1985; Saracho, 1982); 33.3% of the studies (5 of 15) found no significant differences in learners' performance (Guthrie and McPherson, 1992; Orr, 1990; Kerns, 1989; Ybarrondo, 1984; Schroeder and Kent, 1982); only 6.6% (1 of 15) found negative results from those who used tutorial CAI when compared with those who did not used tutorial CAI (Johnson and Churchill, 1986). These figures indicate that instruction through tutorial CAI can be more effective than traditional instruction in

effecting student learning.

Attitudes

75% of the studies (6 of 8) reported that learner attitudes toward subject material were more positive in classes using tutorial CAI than in the classes using more traditional methods of instruction (Guthrie and McPherson, 1992; Plomp et al., 1991; Neapolitan, 1989; Collis et al., 1988; Ybarrondo, 1984; Schroeder and Kent, 1982). 12.5% (1 of 8) found no significant differences (Orr, 1990). 12.5% (1 of 8) found negative results (Saracho, 1982). These results indicate that instruction through tutorial CAI can improve learners' attitude toward subject material.

Learning time

Only one study (Neapolitan, 1989) compared the amount of time necessary for learning material using tutorial CAI with learning through traditional methods. This study defined a desirable level of mastery and measured how much instruction it took for students to reach this level using the different instructional methods. Although negative results were found, it must

be emphasized that this was only one study.

Cost-effectiveness

Only one of the 15 studies examined the cost-effectiveness of tutorial CAI (Edwards, 1986). Even though the study found that TCAI was a money-saving method, one study is not strong evidence to indicate that tutorial CAI can reduce training cost.

Instructional methods

In the 6 studies using TCAI vs. traditional instruction (TCAI vs TI), 50% (3 of 6) found positive results (Edwards, 1986; Smith et al., 1986; Whiting, 1985), 33.3% (2 of 6) found no difference (Kerns, 1989; Schroeder and Kent, 1982), and 16.6% (1 of 6) found negative results (Johnson and churchill, 1986).

In the 3 studies using TCAI vs. self-paced learning without traditional instruction (TCAI vs M), 66.6% (2 of 3) found positive results (Neapolitan, 1989; Emerson, 1988); 33.3% (1 of 3) found no difference (Orr, 1990); and no studies found negative results.

In the 5 studies using combination of TCAI and

traditional instruction vs. traditional instruction (TCAI+ TI vs TI), 60% (3 of 5) found positive results (Plomp et al., 1991; Collis et al., 1988; Saracho, 1982); 40% (2 of 5) found no difference (Guthrie and McPherson, 1992; Ybarrondo, 1984); and no studies found negative results.

The one study using a combination of TCAI and traditional instruction vs. a combination of supplementation and traditional instruction (TCAI+TI vs S+TI) found positive results (Wainwright, 1989). From the comparison of the results it can be concluded that the instructional method using TCAI or using the combination of TCAI and TI is more effective than other methods like traditional method, self-paced learning, and the combination of supplementation and traditional instruction.

Learner level

With regard to learner levels, 10 studies examined graduate and college level student, 60% (6 of 10) found positive results (Plomp et al., 1991; Neapolitan, *1989; Collis et al., 1988; Emerson, 1988; Smith et al.,* 1986; Whiting, 1985); 40% (4 of 10) found no difference

(Guthrie and McPherson, 1992; Orr, 1990; Kerns, 1989; Schroeder and Kent, 1982); and no studies found negative results.

In the 2 studies with high school student, 50% (1 of 2) found positive results (Wainwright, 1989); another 50% (1 of 2) found no difference (Ybarrondo, 1984). One of the 15 studies with non-students, found positive results (Edwards, 1986), and the one with both of student and non-student found negative results (Johnson and Churchill, 1986). On the basis of these results , tutorial CAI appears to be more effective on learning than the traditional instruction in college level. There is a lack of evidence, however, to support the notion of whether tutorial CAI is more effective than traditional instruction in other levels like high school, non-student, or the combination of student and non-student levels.

Subject Area

Subject-specific effects of TCAI were studied in 5 areas, science, social science, manual skills, health education, and basic literacy skills. In the 6 studies focused on science, 83.3% (5 of 6) found positive

results (Plomp et al., 1991; Wainwright, 1989; Emerson, 1988; Smith et al., 1986; Whiting, 1985); 16.6% (1 of 6) found no difference (Ybarrondo, 1984). In the 2 studies in social science, 100% found positive results (Neapolitan, 1989; Collis et al., 1988). In the 3 studies in manual skills, 33.3% (1 of 3) positive (Edwards, 1986), 33.3% (1 of 3) negative (Johnson and Churchill, 1986), and 33.3% (1 of 3) no difference result were found (Orr, 1990). The only study on basic literacy skills found positive results (Saracho, 1982). These results show that tutorial CAI used in the subject of science (such as math, physic, chemistry, and biology) and social science (such as sociology, psychology, and statistics education) tends to be more effective.

Limitation

Limited Number of Studies

There are only fifteen research studies which were reviewed by this study. The quantity of the studies is too limited to provide a large enough sample for conclusive analysis. Therefore, the results from these

studies do not have strong evidence for support.

About the TCAI Software

The quality of the TCAI software is a very important factor within a study. Unfortunately, there is a lack of information about the quality of the TCAI software used by each study. Although different results in learning outcomes were found by the 15 research studies, a question has to be raised; "Were the positive results caused by the good CAI programs or simply a function of the computerized method?" If an experimental group uses a poorly designed TCAI software package can the experimental results be valid? Did the quality of the CAI software influence the results of the studies? In other words, it is not possible to determine variables that may be related to performance in learning if we do not understand the quality of the TCAI software.

About the learners' computer background

Learners' computer background is also very important but there is lack of the information about that. Students who understand computer operations can

usually handle the situation more easy during the CAI instruction. On the other hand, a new computer user usually take a long time to access the system and some of them even have a painful time to practice how to operate the machine at the beginning. These factors might affect the experimental outcome.

Tutorial CAI can be an important tool for teaching and learning. Further research will be needed to identify more precisely the design factors which affect the function of TCAI, and appropriate learning situations for using this new medium--the tutorial computer-assisted instruction.

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