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How Effective Is CAI? A Review of the Research

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What happens when computer-assisted instruction is substituted, in whole or in part, for traditional instruction? Several researchers have found conflicting answers to this and other questions.

FOR the purpose of this review, computer assisted instruction (CAI) is defined as the use of the computer for direct instruction of students. This includes four modes (drill-and-practice, problem-solving, simulation, and tutorial) but does not include computer managed instruction or the teaching of computer science. Only studies are included in which effectiveness was measured by student achievement as a result of CAI as compared with achievement resulting from other methods of instruction.

CAI as a Supplement to Traditional Instruction. CAI is commonly provided to students in addition to normal, classroom instruction. As shown in Figure 1, when that is the case, all studies have shown

normal instruction supplemented by CAI to be more effective than normal instruction alone.

In some cases the results were quite remarkable. In the Suppes (31) study, for example, third grade students in California and Mississippi whose normal instruction was supplemented with CAI gained, respectively, 2.28 and 2.03 grade levels in computational ability in one year. Arnold (3) and Scrivens (29) found that after one year the differences in achievement between students whose arithmetic instruction was supplemented by CAI drill and practice and students who received normal instruction were only .3 grade levels for grade two, .5 for grade three, .4 for grade four, and .5 for grades five and six (all favoring the CAI students). Fletcher and Atkinson (13) found that students who received supplementary CAI instruction in reading scored, at the end of a year, an average of .6 grade levels higher on a standardized test than students who received normal classroom instruction only. Wilson and Fitzgibbon (32) reported that a group of fourth and fifth graders made an average of seven months growth in reading

Study	Mode	Subject	Grade Level	Results *
Arnold	Drill & Practice	Arithmetic	3 - 6	+
Crawford	Drill & Practice	Arithmetic	7	+
Martin	Drill & Practice	Arithmetic	3 - 4	+
Scrivens	Drill & Practice	Arithmetic	3 - 6	+
Suppes	Drill & Practice	Arithmetic	2 - 6	+
Fletcher and Atkinson	Tutorial	Reading	1	+
Bitter	Problem Solving	Calculus	College	+
Culp	Simulation	Chemistry	College	+
Lagowski	Mixed	Chemistry	College	+

* In this and subsequent figures, a + indicates that the students involved in CAI achieved more than non CAI students. A - indicates that the CAI studies did less well, while an = indicates the same level of achievement.

Figure 1. Studies That Involved CAI as a Supplement to Traditional Instruction

skills during four months as a result of having their normal instruction supplemented with CAI.

CAI as a Substitute for Traditional Instruction. As shown in Figure 2, when CAI was substituted, in whole or in part, for tradi-

tional instruction, nine studies showed that the CAI students achieved more than the non-CAI students, while eight studies found little or no difference. Three of the studies (1, 18, 33) showed mixed results.

Effectiveness of Different Modes of CAI. Figure 3 shows the results of studies of the effectiveness of CAI categorized according to the various modes.

As shown in Figure 3, from the evidence available it cannot be concluded that any mode of CAI is consistently more effective than other modes. Each mode of CAI has been shown to be more effective than traditional instruction in some studies but no more effective in other studies.

Comparison with Other Nontraditional Methods of Instruction. Figure 4 lists three studies in which the effectiveness of CAI has been compared with other nontraditional methods of instruction. CAI has been shown to be equally effective when compared with individual tutoring, language laboratory, and

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Compression of Time. Several studies have shown that even though CAI does not always result in greater achievement, the time it takes students to learn is reduced. Those studies are shown in Figure 5.

As shown in Figure 5, when student time to learn was measured, all studies

Study	Mode	Subject	Grade Level	Results
Abramson	Drill & Practice	Arithmetic	2 - 6	+, = *
Street	Drill & Practice	Arithmetic	3 - 7	=
Wilson	Drill & Practice	English	4 - 5	+
Cole	Drill & Practice	General Math.	High School	+
Adams	Drill & Practice	German	College	+
Morrison	Drill & Practice	German	College	=
Atkinson	Tutorial	Reading	1	+
Morgan	Tutorial	Algebra	High School	+
Lorber	Tutorial	Tests & Measurement	College	+
Cropley	Tutorial	Fortran	College	=
Proctor	Tutorial	Curriculum	College	=
Johnson	Problem Solving	Mathematics	7 - 9	=
Katz	Problem Solving	Algebra	High School	+, - *
Wing	Simulation	Economics	6	+, - *
Lunetta	Simulation	Physics	High School	+
Culp	Simulation	Chemistry	College	=
Hollen	Simulation	Chemistry	College	=
Diamond	Mixed	Biology	7 - 10	+
Diamond	Mixed	Reading	7 - 10	=
Cartwright	Mixed	Education	College	+

* These three studies produced mixed results.

Figure 2. Studies That Involved CAI as a Substitute for Traditional Instruction

Study	Mode	Subject	Grade Level	Comparison	Results
Culp	Simulation	Chemistry	College	Tutoring	=
Morrison	Drill & Practice	German	College	Lang. Lab.	=
Street	Drill & Practice	Arithmetic	3 - 7	P.I., Films	=

Figure 4. Studies Comparing Effectiveness of CAI with Other Nontraditional Methods of Instruction.

Study	Mode	Subject	Grade Level	Results	
				Achievement	Time *
Kockler	Tutorial	Mathematics	College	=	-
Lorber	Tutorial	Testing	College	+	-
Proctor	Tutorial	Curriculum	College	=	-
Krupp	Tutorial	Computer Programming	Adult	=	-
Sango	Tutorial	Electronics	Adult	=	-
Wing	Simulation	Electronics	6	=	-
Lunetta	Simulation	Physics	High School	+	-
Hollen	Simulation	Chemistry	College	=	-
Cartwright	Mixed	Education	College	+	-

* A - indicates that less time was required by CAI students.

Figure 5. Studies That Separated the Time Required for Students to Learn Through CAI Compared with Other Methods of Instruction

showed that it took less time for students to learn through CAI than through other methods. Krupp (20) showed that adults learning computer programming through CAI took from five to 10 hours to reach the

Mode	Study	Subject	Grade Level	Results
Drill & Practice	Arnold	Arithmetic	3 - 6	+
	Martin	Arithmetic	3 - 4	+
	Scrivens	Arithmetic	3 - 6	+
	Suppes	Arithmetic	2 - 6	+
	Crawford	Arithmetic	7	+
	Gipson	Arithmetic	7	=, +
	Abramson	Arithmetic	2 - 6	=, +
	Street	Arithmetic	3 - 7	=
	Cole	Gen. Math.	High School	+
	Wilson	English	4 - 5	+
Tutorial	Adams	German	College	+
	Morrison	German	College	=
	Atkinson	Reading	Intermediate	+
	Fletcher and Suppes	Reading	Intermediate	+
	Morgan	Algebra	High School	+
	Cropley	Fortran	College	=
	Krupp	Computer Prog.	Adult	=
	Lorber	Testing	College	+
	Proctor	Curriculum	College	=
	Sango	Elections	Adult	=
Problem Solving	Johnson	Mathematics	7 - 9	=
	Katz	Algebra	High School	+, -
	Bitter	Calculus	College	+
Simulation	Wing	Economics	6	+, -
	Lunetta	Physics	High School	+
	Culp	Chemistry	College	+
	Culp and Castleberry	Chemistry	College	=
	Hollen	Chemistry	College	=
Mixed	Diamond	Biology	7 - 10	+
	Diamond	Reading	7 - 10	=
	Lagowski	Chemistry	College	+
	Cartwright	Education	College	+

Figure 3. Effectiveness of CAI According to Mode

same level of proficiency as students who spent from 24 to 30 hours in traditional instruction. Lunetta and Blick (23) compared computer simulation of high school physics experiments with traditional laboratory experiments and found that the CAI students learned more in one eighth the time.

Retention. Even though students may learn more or may learn more quickly through CAI, there is some evidence that they may not retain as much as traditionally taught students. As shown in Figure 6, although one study showed retention to be equal, two studies showed that students who learned through traditional methods retained more of what they had learned than students who learned through CAI.

Effectiveness According to Ability Level. Only two studies reported results according to ability level of students. Both Martin (24) and Suppes (31) found CAI drill and practice in arithmetic to be relatively more effective for low ability students than for average or high ability students.



Study	Mode	Subject	Grade Level	Results *
Wing	Simulation	Economics	6	—
Lunetta	Simulation	Physics	High School	—
Proctor	Tutorial	Curriculum	College	=

* A — indicates that the CAI students retained material less well than the non CAI students.

Figure 6. Studies That Compared Retention of Material Learned Through CAI with Retention of Material Learned Through Other Methods

Study	Mode	Subject	Grade Level	Results
Martin	Drill & Practice	Arithmetic	3 - 4	Low +
Suppes	Drill & Practice	Arithmetic	2 - 6	Low +

Figure 7. Studies That Compared the Effect of CAI on Students of Different Abilities

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