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ABSTRACT

The purpose of this paper is to examine the literature in regard to technology and its effect on learner academic achievement. It explores early assumptions and current academic practices, examines several seminal studies on technology effect, and looks at possible future directions for technology and learning research. The paper offers the following conclusions: technology is a design science, not a natural science; if there is no relationship between technology and learning, it is because one has not yet been made. The near term future will integrate all of these separate technologies into one delivery mode, and if educators do not see, use or understand the links between technology and learning, they may find themselves on the "sidelines of their own game." Learning consists of active, constructive, cognitive, physical and social processes. To understand a relationship between technology and learning, the relationship between cognitive processes and the environment must be seen. No matter what medium is used to teach, it is still up to the teacher to inspire the student to want to learn. If technology is not appropriately used to enhance learning, students will become numb instead of enlightened. (AEF)

Technology Effect: The Promise of Enhanced Academic Achievement

by

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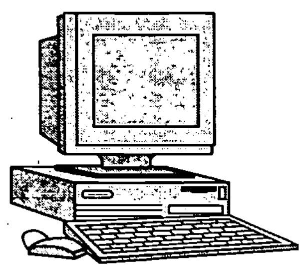

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I. Introduction

Education is moving learning away from the static, face-to-face, one-way instructional system so common in our schools and colleges. It is important to examine technology, this new delivery medium, because comprehensive, interactive technology to enhance student achievement will be the dominant knowledge delivery mode in the 21st century (Gray, 1988).Technology (educational) has three distinct meanings. It is a a) product [hardware, software], b) process, [application of scientific knowledge to education] c) or both [distance learning] (Gray, 1988).

The other knowledge delivery modes of the mediums are:

- Print [correspondence study]
- Television/radio
  - a. open circuit public television
  - b. commercial TV
  - c. videocassette players

  that will have the capacity to easily
  - a. reach large audiences
  - b. relatively low per-unit costs
- Cable: cost-effective context for distance learning [distal limits]
- Satellites
  - a. deliver audio and video to sizable abidances covering vast areas.
  - b. not cost-effective at local level
- Computers: use of Internet, networks, programmed, etc.

Definition:

Technology, specifically educational/instructional technology is used as a generic descriptor and includes concepts as instructional technology, educational media, learning technology, and other variants. One of the more accept definitions currently used is:

> Instructional Technology is the theory and practice of design, development, utilization, management, and evaluation of processes and resources for learning.

This definition reflects, in part, the purpose of this presentation, the use of technology as learning resources and processes (Reiser & Ely, 1997).

Definition:

Learning...

Is it the ability to access information?

Is it being able to create a great report or communicate something to somebody?

Learning is where "you run into some situation in the real world that you don't know quite what to do with and you look it over and figure out what to do with it, that's a real example of learning" (Skolnik & Smith, 1993, p. 5).

Purpose: The purpose of this presentation is to examine the literature as regards to technology and its effect on learner academic achievement.

Approach: This presentation will explore early assumptions, current academic practices, examine several seminal studies on technology effect, and wind down by looking at possible future directions for technology and learning research.

Limitations:

1. ASU serial collection, regional interlibrary loan, main collection.
2. Absence of government studies due to time limitations.
3. This presentation is just a broad overview of the major issues and findings of technology and learning and does represent a comprehensive examination of this complex topic.

II. Early Assumptions

The influence of technology and learning have been an important feature of educational research since Thorndike [in 1912] recommended use of pictures as a labor-saving device in classroom instruction. (Clark, 1983)

Early use of technology focused on "media selection" believing that learning would be enhanced through the proper mix, or selection of a medium, students, subject matter, content, and learning task.

The Clark Declaration

Richard Clark, in an important study conducted an examination of various meta-analyzes and other research which upset current (1983) beliefs about the promise of technology stating "most current summaries and meta-analyzes of media comparison studies clearly suggest that media do not influence learning under any conditions" (p. 445).

> The best current evidence is that media are mere vehicles that deliver instruction but do not influence student achievement any more than the truck that delivers our groceries causes change in our nutrition. (p. 445)

The problems with the studies revolved around:

-ambiguous data = "no significant difference" or "equally effective."

-"novelty" effect = temporal issues "studies lasting only a few weeks"

i.e.,	Study	Length	Results
	Computers	4 wks	.56 sd
	Computers	5-8 wks	.3 sd
	Computers	8 wks	.2 sd

-editorial issues = articles with high results had better chance of being published. Low or no effect is not publishable in most journals.

-attribute issues = study the way attributes of media influences the way information is processed [fast- slow-motion, wide angle, zoom-in] to provide learning cues. These attributes facilitate learning but they are not media [i.e., zooming].

III. Current Practice

Attitude:

When used well technology enhances the quality of teaching. The student-teacher relationships in classes that incorporate technology are more like mentor and the apprentice, where the apprentice, the student, actually does the work to educate themselves and the teacher changes from a sergeant-at-arms to a mentor or coach.

The Foundation for the Advancements in Science and Education (FASE) conducted a study (1993) of teacher attitudes toward technology in the classroom. Using random sample of nine US cities 128 teachers responded

- 51% = willing and interested in how to use new technology
- 43% = really looking forward to it
- Over half supported the statement "It's going to make a big, positive difference to education."
- Less than half checked, "I think it might be a good thing"
- No teacher supported, "It could actually be destructive to the educational process"
- Kids get their information from technology
- In 1990 = The child in school today is very, very different than ourselves as a 'kid-in-school':
    - 6,000 hours in front of television per year
    - 20,000 hours by time graduation from HS
      12,500 in classroom.
- ETS (1993) reported kids spend 12 times more time watching television than they do outside, reading for pleasure [2 hrs reading; 27 hrs television] (FASE, 1993)

Distribution: [Hawkins, 1995]

Present situation:

- 1984 - computer/student ratio [1/125]
- 1995 -computer/student ratio [1/9]

Uneven distribution = range is 1/7 to 1/35

Role of federal government "level the playing field"
For schools: 1994
= wealthy schools [-4% minority] = ratio 1/14
= poor schools [+24 minority] = ratio 1/18
1994 For students:
= schools with 80% Chapter 1 = 7.2/100
= schools with -20% Chapter 1 = 8.6/100
Problems with current capacity:

- 1994= 85% of installed computers cannot support multimedia or "connectivity."
- 1994= 5% of computers are old 8-bit machines.
- 1994 =35% Internet capable

1995; 85% had wide area networks–but for administrative purposes.

- Local area network = 20%
- Wide area network = 14%
- Telecommunications = 7%

1995 = Of 917 schools surveyed by DOE of 917 schools = 50% Internet capable

Home computers [by wealth]

1995	home computers	on-line services	e-mail
$50K =	57%	14%	16%
$20K =	12%	1%	2%

Teacher Practice: Inadequate teacher preparation for technology based classrooms.

One of the first, and most important steps, to alleviating the confusion about the proper uses of technology in the classroom begins in the teacher education programs. Colleges' of education are aware of the preparation gap between what the faculty teaches in the curriculum and what they know is needed for teacher preparation in using a technology-based classroom and what exist in their teacher education curricula. A recent survey of education professors revealed that 76% indicated that information technology is now a very important aspect of education; 82%

said this information technology would come into its own within a decade. However, when recent education graduates were polled more than 50% reported that they were poorly prepared to understand or use current information technology (Barksdale, 1996). Further, only 3% felt they were well prepared." Few of these new teachers were able to work collaboratively over networks, use E-mail, or access other information technology services or capabilities. The end result of this shortfall is that public schools have to re-train these teachers on the use of technology in the classroom. This sophisticated and dynamic training has become an additional burden to schools already bowing under other pressures related to change and performance (Long, 1987).

Training teachers in information technology has to be carefully planned because the hardware and software elements can be intricate and even complex if not properly broken into teachable elements. Added to this complexity is the issue of obsolescence. Information technology, i.e., computers, software programs, data-bases, is very dynamic. You can buy a computer and software in 1994 which was state-of-the-art, by mid-1995 this same equipment is obsolete to the point parts are no longer available for repair. Within two decades of the introduction of technology into the classroom, a pattern has emerged that duplicates the introduction of radio in the 1920s and film in the 1930s, into classroom use. Follow up research found that there was limited use of those technologies in American classrooms (Cuban, 1995). The reason for this is twofold, first schools of education do not properly prepare todays' teachers in the uses of technology in the classroom (Barksdale, 1996).

Second, school administrators use a different set of criteria in determining the usefulness of technology in the classroom than teachers. Teachers, the actual day-to-day users of technology in the classroom, make their decisions on using technology related to issues about how easy the technology is to learn and operate, how much time and energy does it take to maintain it, and how reliable is the technology. Administrators make their decisions about technology in the classroom on a cost per pupil and how it could revolutionize teaching and learning. The reality about technology in the classroom is that without wider teacher enthusiasm the end result is that students spend about one hour a week involved with technology. This hands-on technology is less than 4 percent of all the instructional time (Cuban, 1995).

Summary of Empirical Studies:

Study	Population	Medium	Results
Boschee (1997)	Meta-analysis	Technology	No change
Brush (1997)	65 5th graders	ILS	+/groups
Cennamo (1993)	42 female students	Domain/medium	+learning
Chen (1997)	None	Distance leaning	+w/limits
Cockayne (1991)	216 bio students	I- videodisc	+w/limits
Justen (1988)	64 students	CAI	No change
Whetzel (1996)	1,177 workers	Satellite	+ change
Young (1996)	26 7th graders	CBI	+w/limits

The studies suggest that positive change could be related more closely to factors other than technology. In particular the Young, et al. study begins to surface the proposition that for higher order learning more attention needs to be paid to cognitive process supported by appropriate supporting uses of the various mediums/domains of technology.

V. Future Directions

Classroom of Tomorrow - Where the latest computer technology is always at hand and at the disposal of students and teachers.

Computers will become personal assistants for tomorrow's student.

With our minds, and obviously with the help of technology, we've got the choice of using all of this [world's] enrichment to enhance our lives or, of course, the terrible opposite, awful choice of bringing it all down. (Skolnik & Smith, 1993, p. 8)

VI. Conclusions

Will Technology Influence Learning? Reframing the Solution.

- Technology is a design science, not a natural science. If there is no relationship between technology and learning, it is because we have not yet *made* one.
- The near term future will integrate all of these separate technologies into one delivery mode, if educators do not see, use or understand the links between technology and learning, we may find ourselves on the sidelines of our own game.

In part, we have not forged a relationship with technology because of vestiges of the behavioral roots from which our discipline sprang.

*the criterion-referenced tests of current instructional designs.

* recent/past studies are the S-R of the behavioral paradigm...

...media are classified and differentiated based on surface features of the technologies, with learning compared using tests responses.

* Missing are notions of the cognitive, affective, or social processes by which learning occurs.

* Missing are underlying structure and functions of technology which serve as causal mechanisms.

'the medium is an inert conveyer of an active stimulus to which the learner makes a behavioral response.'

- Learning are active, constructive, cognitive, physical, and social processes.

- To understand a relationship between technology and learning we must see the relationship between cognitive processes and the environment.

- No matter what medium is used to teach, it is still up to the teacher to inspire a student to want to learn.

-

If technology is not appropriately used to enhance learning, then the students will become numb instead of enlightened.

Technology forces us to choose between quality and convenience.

For example,

> Compare the emotions evoked by great painting and illuminated manuscripts with those evoked by excellent phonographs of the originals...There is an understandable tendency to accept the substitutions as though nothing were lost. Consequently, little protest has been made over replacing high-resolutions phonographs of great art...With lower-resolution video-disk images which distort both light and space even further. The result is that recognition, not reverie, is the main goal in life and also in school, where recognition is the highest act to which most students are asked to aspire. When convenience is valued over quality in education, we are led directly to 'junk' learning. (Skolnik & Smith, 1993, p. 6)

As regards, technology's direct link to improved student achievement, the promise is still unfulfilled.

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*works actually used in compiling study. Over 100 separate research, opinion, and essay type works were examined in the assembling of this piece.

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The Promise of Enhanced Academic Achievement

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Presentation Outline

- Introduction
- Early Assumptions
- Current Practice
- Literature Review
- Future Directions
- Conclusions

Early Assumptions

- Clark Declaration
  - Richard Clark
    - ambiguous data
    - "novelty" effect
    - editorial issues
    - attribute issues

Current Practice

- Attitude
- Distribution of Technology
- Problems with Current Capacity
- Teacher Practice
  - teacher education
  - school administration

Literature Review

- Empirical Studies
  - purpose
  - procedure
  - learning effect

Future Directions

- Classrooms of Tomorrow
  - technology as assistant
- Students of Tomorrow
  - geometric accumulation of, and access to, knowledge
- Computers as Personal Assistants
  - "net" replaces text
  - digital vs analog

Conclusions

- Will Technology Influence Learning?
  - design science vs natural science
    - influence is made
  - behavioral vs cognitive
    - technology is not S-R, it is a constructive, cognitively stimulating tool (analogous to a work of art)
- Reframe the Solution
- A PROMISE YET UNFULFILLED

Studies Relevant to Technology Effect: A sample

Boschee, F. (1997). Small-group learning in the information age. Clearing House, 65(1), 89-92.

Purpose: This article takes the view that society has changed, so teaching and learning processes also must change. Teachers must be analyst and facilitators and minimize teacher talk and seat work.
Procedure: A meta analysis of the literature regarding teaching and learning.

Results:
People remember 10% of what they read
20% of what they hear
30% of what they see
50% of what they hear and see
70% of what they say
90% of what they say as they do a thing.
Relevance to Learning Effect: Even though teachers are aware that we live in a new age and that the thrust of education has changed, teachers continue to teach within a limited repertoire, emphasizing teacher talk, monitoring on-task seat work.

Brush, T. A. (1997). The effects on student achievement and attitudes when using integrated learning systems with cooperative pairs. Educational Technology Research & Development, 45(1), 51-64.

Purpose: to determine whether the use of cooperative learning strategies with an integrated learning system [ILS/CAI] produced academic and attitudinal gains.

Procedure: [Slavin]...examines 99 studies comparing cooperative learning with individual effort. Subjects were 65 5th grade students in an elementary school. [63 reported significant achievement improvement in learning as cooperative learning. Only 5 show individual achievement better than cooperative.]

The study used a two-group [cooperative v. individual] posttest-only [California Achievement Test, 5th ed.] design to determine achievement differences.

Results: Statistically the adjusted mean for students in the cooperative group was significantly higher than the adjusted mean for students in individual group. Thus, students working on the ILS in dyads performed significantly better on the achievement test than students working on the ILS individually.

Results ILS/cooperative group improvement =	53.75 *m*
Results individuals =	49.14 *m*

Previous studies also found that students working in cooperative groups performed significantly better on tests [academic, higher order skills].

Attitudes towards math:

Cooperative	"Do you like math?"	91 [n=44]
Individual	"Do you like math?"	57 [n=21]

Relevance to Learner Effect: Cooperative learning using ILS [integrated learning system].

Use of cooperative learning techniques aligned with ILS improves learning and attitudes about content/subject.

Cennamo, K. (1993). Preconceptions of mediated instruction for various learning techniques. International Journal of Instructional Media, 20(3), 1-12.
Purpose: identify specific preconditions of perceived difficulty by medium as regard learning material. This research explores the relationship between preconceptions and actual achievement.

Procedure: This exploratory study examined whether the preconceptions of the learning domain [verbal, intellectual, affective, psychomotor] or the medium of presentation [interactive, video, computers, television, books] influenced learning gains. Forty two female students participated in study. A questionnaire, interviews with some participants selected for follow-up interviews. Ratings were summed by medium and domain. ANOVA and Coefficients were obtained for each domain and medium.

Results:
Interactive video was perceived to be the easiest to learn from [m=23.14]
Books were perceived as the hardest [m=31.45]
Computers were perceived to be easier than books and television [m=26.93]
Television was perceived to be easier than books [m=24.94].
Verbal information was easier to learn [m=26.50]
along with attitudes [28.50]
than intellectual [m=28.50]
than psychomotor [m=29.74].

Among media and learning, it was easier...
Learn psychomotor skills from television [m=6.05] and interactive video [m=5.81]
but not easier from computers [m=8.24] and books [m=9.64]

Learning attitudes, easier from...
television [m=5.45] and interactive video [m=5.74]
than from computers [m=7.52] and books [m=7.79]
Learning intellectual skills easier from...
interactive video [m=6.26] and computers [m=6.36]
than from books [m=7.19] and television [m=8.69]
Learning verbal information it was easier using...
computers [m=4.81] and interactive video [m.5.33], but less easy from books [6.83] and television [7.95].

By medium by mean it was:

	Verbal information	Intellectual skills	Attitudes	Psychomotor skills
Books:	6.83	7.19	7.79	9.64
Television	7.95	8.69	5.45	6.05
Computers	4.81	6.36	7.53	8.24
Interactive video	5.33	6.26	5.74	5.81

Preferences fell into categories:

1st symbol systems [presence or absence of item]

2nd processing capabilities

3rd learner preferences

4th physical limitations [books easier to tote]

5th task characteristics

Relevance to Learning Effect: This study challenges Clark's Declaration and proposed that the capabilities of a particular medium, in conjunction with methods that take advantage of these capabilities and whether they correspond to the particular learning situation [tasks and learners] and the way the medium is used by instructional design.

Chen, Li-Ling (1997). Distance delivery systems in terms of pedagogical considerations: A reevaluation. Educational Technology, 37(4), 34-37.

Purpose: The paper reevaluated technology learning systems in terms of pedagogical considerations.

Procedure: The study limited itself to five technology distance learning systems. These were compared with four pedagogical issues [interaction between instructors and students; instructional strategies; motivation; feedback/evaluation]. No statistical procedures appear to have been used.

Results:

Table 1

Assessment of technology systems with Pedagogical considerations

System	Teacher/ Learners	Instructional Strategies	Motivation	Feedback/ Evaluation
Print	One-way	Confined to mailings	Yes, depending on the design	Delayed
Video Conference	Two-way; Multiple-way	Approximates face-to-face; Lecture; Panel of experts Discussion; Interviews.	Very strong	Immediate
Video	One-way	Lecture; Tutorial	Limited	None
Interactive videodisc	One-way	Lecture; Tutorial; Simulations	Limited	Confined to feedback program
Computer Assisted Instruction	One-way	Tutorial; Simulations	Yes	Delayed
Internet; WWW; e-mail	Two-way; Multiple-way	Online discussion; electronic Researching; Problem-Solving Activities	Strong to very strong	Immediate; delayed depending on the occurrence of learning activities

Relevance to Learning Effect: With distance education technology it is crucial that the learner's materials be relevant and appropriate to the situation. Teachers must have a clear understanding of the instructional implications of these systems, especially when they are mixed and matched.

Cockayne, S. (1991). Effects of small group sizes on learning with interactive videodisc. Educational Technology, 31(2), 43-45.

Purpose: This study compared group size on learner achievement using interactive videodisc as the instructional medium.

Procedure: Quasi-experimental design using 216 students enrolled in introductory biology class at Brigham Young University. It was organized into three treatment groups

singles	n=1 [23]
small groups	n=2/3 [28 dyads]
groups	n=4/5 [25 groups]

Computer controlled interactive videodisc lesson with verbal learning the outcome. Achievement was measured using 12 item pencil & paper pretest and posttest. Instructional efficiency calculated at

$$\frac{\text{achievement X F}}{\text{Time}}$$

Where F = 1 for singles
2.6 for 2/3 students
4.8 for 4/5 students

Result:

Table 1
Pretest and Posttest Scores

Number of Students Per Group	Pretest*		Posttest*
1	Mean	2.48	10.26
	SD	2.06	1.51
2 or 3	Mean	3.36	10.00
	SD	2.34	1.69
3 or 4	Mean	2.57	9.39
	SD	2.20	2.11

* total possible = 12.

Table 2
Average Instructional Time
[Time in Minutes]

Number of Students Per Group	Mean	SD
1	57.65	19.91
2 or 3	63.49	13.06
3 or 4	68.60	21.24

No significant differences are evident as regards to single or group learning.
There was greater instructional efficiency with larger groups [4/5]; Groups of 2/3 also leaned more efficiently than singles.

<u>Relevance to Learning Effect:</u> It would be effective to have group learning when using this technology, in particular in higher order learning.

Justen, J. E. III, Adams, T. M. II, Waldrop, P. B. (1988). Effect of small group versus individual computer-assisted instruction on student achievement. Educational Technology, 38(2), 50-52.

Purpose: To examine the effects of group versus individual CAI on achievement of students taking an introductory course on special education.

Procedure: A quasi-experimental design using 64 students enrolled in two classes using CAI. Both classes received CAI in a counter-balanced order [one class received group CAI in first half of class while the other sections received individual CAI; the delivery mode was switched between sections at mid-term].

Four objectives tests of the same composition was given to all students. The 'Brown' scale {Likert-type}. The mean was used with 1.0 being most favorable and 5.0 least favorable. The Brown scale [posttest] was given at the same time as final test.

Results:

Table 1
Croup Versus Individual CAI Test Scores

Condition	N	$\bar{X}$	SD
Individual	64	167.03	22.05
Group	64	167.84	22.38

T = 207, 126 df, p> .05

NOTE: no statistical differences in student achievement.
[55% of the literature on CAI and Achievement reported no statistical difference.]

[45% found CAI more effective.]

Table 2
Pretest and Posttest Attitude Scores
for Section 1 and 2

Section No. 1	*N*	X	SD
Pretest	30	2.93	.50
Posttest	33	2.15	.36

$T = 7.09$, 61 df, $p<.001$

Section No. 2	*N*	X	SD
Pretest	29	2.62	.32
Posttest	30	2.11	.44

$T = 5.02$, 57 df, $p< .001$

NOTE: Attitudes were statistically different for both sections from using CAI
Also significantly greater number of students favored individual to group work on CAI.

<u>Relevance to Learning Effect:</u> The authors suggest a less general approach looking at individual and paired use of CAI. This study examines this issue of individual vs. paired CAI usage.

While no statistical significance between Group/Individual CAI for student achievement. Students have a decided preference for individual CAI.
Overall, group CAI is just as effective in regard to achievement as individual CAI for college students.

Other studies concluded that CAI made small but significant differences in academic achievement of college students.

Overall: another meta-analysis found that CAI students received higher scores than students receiving traditional instruction.

Of the 48 studies reviewed; only 23 reported a statistically significant difference in favor of a technology effect.

Whetzel, K. L., Felker, D. B., & Williams, K. M. (1996). A real world comparison of the effectiveness of satellite training and classroom training. Educational Technology Research & Development, 44(3), 5-18.

Purpose: to assess the effectiveness of satellite training achievement for specific job procedures.

Procedure: Postal Service managers will a minimum of 6 years service all with recent promotions and were being trained on new mail-processing technologies. Target population was 1,177 individuals with 85% attending the satellite training. The study examined the characteristics of eight courses. Prior to each course a local facilitator administered the pretest. The courses were delivered in lecture format with graphics. The students were forward-facing to monitors and interactivity was used student-student and student-facilitator.

Results: The extent to which students learned course content was measured by pencil-and paper-tests in a pretest and posttest format. Differences between satellite and classroom delivered courses were compared.

Table 1

Comparison of Pretest and Posttest Scores for Satellite and Classroom Courses

Course	Mean Score (%) Pretest	Mean Score (%) Posttest	Average Score Gain (%)	*N*
Automation Basics	54.8	74.5	19.7*	68
Automation for Delivery	55.8	82.5	26.7*	201
Remote Bar Coding	37.5	54.2	16.7*	254
Adv. Facer Canceler	64.0	64.9	.9	96
Flat Sorting Machine-Operations	53.9	72.4	18.5*	33
Flat Sorting Machine-Sort Plans	75.6	91.2	15.6*	41
Automation Systems and Programs (satellite)	50.0	80.6	30.6*	157
Automation Systems and Programs (classrooms)	46.7	75.7	29.0*	90
Mail Counts and Route Inspections (satellite)	65.7	81.4	15.7*	77
Mail Counts and Route Inspections (classrooms)	59.2	71.6	12.4*	72

* $p < .0001$

Relevance to Learning Effect: The value of satellite training/learning was supported by the consistency of results.

The magnitude of the differences for seven of the eight courses in gain scores and the consistency of gain across a number of different courses provide some evidence that satellite training/learning can influence different learning outcomes.

The mean posttest scores for those who received their training by satellite were slightly larger [statistically significant] than the means for those who received their training in a traditional classroom format. Uneven results of satellite effectiveness, some basis of support for higher education and military uses, but little support for K-12. This study just serves as a continuation of the long simmering controversy about attributing learning effects to instructional media.

Young, J. D. (1996). The effect of self-regulated learning strategies on performance in learner controlled computer-based instruction. Educational Technology Research & Development, 44(2), 17-27.

Purpose: This study examined learner control vs. program control using CBI. Bandura's social cognitive theory provide one framework for investigating one aspect of learning with technology.

Procedure: Subjects were 26 7th grade student enrolled in a social studies course at a middle school. Two CBI lessons were the instructional materials. There were four concepts and six instructional events for a total of 24. There was a CBI/pencil-and paper pretest and posttest.

Results: revealed that the performance differences between learners with high SRLS and low SRLS were greater under learner control than under program control. Poor performance by subjects with low SRLS under learner control indicates a strong need for learners to possess self-regulating learning strategies to achieve success. However, program control appears to minimize performance differences between high and low SRLS.

Table: 1
Means and Standard Deviations of Posttest Scores
Across Treatment Conditions
Type of Control

	Program Control			Learner Control			Totals		
SRLS Level	M	SD	*n*	M	SD	*n*	M	SD	*n*
High	64.7	30.3	7	73.2	16.7	6	69.0	24.4	13
Low	67.7	30.7	6	37.0	12.1	7	52.3	26.8	13
Totals	66.1	29.2	13	53.7	23.3	13	59.9	26.6	26

Relevance to Learning Effect: study illustrates the need for the learner to control their own learning in order to get the most of the situation, with or without technology.
The results prompted the comment "I believe it is now time to stop asking the research questions 'which is better: learner or program controlled CBI? It seem that enough research has been produced to date to justify the conclusion of 'take your pick'" (p. 25).

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