New and Improved, or Just New?

When the initial excitement of their new technology subsides, will trainers be left with more than big dents in their budgets?

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Training technology can captivate an instructor like an eager kid in a toy store. Training managers—the ones with true purchasing power—are offered an array of choices today. The development of low-cost mini- and microcomputers and software has sparked a dramatic increase in computerized training. But one must stop and wonder: Does newer and cheaper necessarily mean better when it comes to systems that must last a long, long time? And will the same system that works in one training application be equally successful for all others?

Effectiveness and efficiency

Training effectiveness is the degree to which training objectives are realized. Such objectives pertain to trainee attitudes, learning and job performance. Training efficiency relates training effectiveness to cost. The trick is to achieve all the objectives at the lowest possible price.

Computer-assisted instruction (CAI) frequently is cited as a means of increasing training effectiveness. This belief is backed by three CAI characteristics: (1) It is tightly structured, stating clearly the criteria for "successful learning"; (2) With CAI, trainees cannot assume they know the material and take shortcuts; and (3) The man/machine interaction involved in CAI may be motivating to trainees.

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Relatively little attention, however, has been given to the cost efficiency questions surrounding CAI. An exception is a report on CAI in Air Force basic electronics training. Two studies were conducted. The first compared students of varying ability levels in a conventional classroom with a similar sample of students trained via CAI. Although there were no differences in achievement scores (training effectiveness), the CAI group posted a 34 percent reduction in training time (a training cost factor). The second study compared very high ability students trained via CAI with students using a self-paced text. The CAI-trained students not only earned significantly higher examination scores, but also completed their training in 25 percent less time. The implication of these two studies is straightforward: Training efficiency can be increased by increasing effectiveness, reducing costs or both.[1]

Looking past the shine

A recent development in CAI was the merging of computers with video to create interactive video programs. Interactive video permits visual images stored on disk or tape to be incorporated into CAI training sequences. Using one or more video screens, text and animated graphics or videotaped material are presented to the trainee through a computer. More complex programs permit written material to be overlaid directly on the video display.

Recent articles have proclaimed the potential advantages of interactive video over conventional CAI. One article suggests that including a visual image enlivens instruction and improves comprehension.[2] Another emphasizes the motivational potential of interactive video, saying it produces greater trainee involvement and enhances the learning process.[3]

These notions seem plausible, but they have not been verified. To date, no research has been published concerning the training effectiveness of CAI versus interactive video. Many questions remain. For example, are there significant differences in the effectiveness of these two media in training factual knowledge? If the training pertained to a supervisory skill, such as giving recognition for good performance, and training effectiveness was measured behaviorally (e.g., ratings of role-play performance using the skill), which method should be used? These questions are important not only in terms of instructional design considerations (effectiveness), but also in terms of cost. CAI itself is an expensive training method. The incorporation of interactive video involves additional expense that might not be cost-effective.

Although such criterion-specific research comparing CAI and interactive video is lacking, several studies may serve as a guide in choosing between these or other instructional methods. Two studies (King; Lahey, Crawford and Hurlock) examined the effects of adding graphic displays to text-only CAI programs (see Table 1).[4,5] In these studies, training was concerned primarily with acquiring factual information. Paper-and-pencil tests were used to evaluate training effectiveness. Because the addition of graphics did not result in significantly higher test scores, the results suggest that the added cost of graphics cannot be justified. In addition, a programmed text is favored over either CAI or interactive video because the latter methods involve higher costs with no significant increase in training effectiveness. It is possible that any positive effects of graphics might have been reflected in behavior or performance, but such criteria were not included in these studies.

Table 1 also shows the results of the Davis and Mount study. This study investigated the effectiveness of CAI and behavior modeling for training in conducting performance appraisals. Behavior modeling is a training technique that involves: (a) presentation (usually on film or videotape) of the behaviors trainees are to learn; (b) mental rehearsal of the modeled behaviors; (c) practice of modeled behaviors; and (d) feedback from a trainer, other trainees or videotapes of the

Table 1—Training Effectiveness Studies of CAI and Graphics

Study	Training Conditions	Training Content	Results
King	A. CAI text + animated graphics B. CAI text + still graphics C. CAI text alone	Sine-ratio concept	No significant differences in multiple-choice test performance.
Lahey, Crawford and Hurlock	A. CAI + still graphics B. Self-paced text (booklets)	Multimeter usage	No significant difference in test scores.
Davis and Mount	A. Control (no training) B. CAI only C. CAI + behavior modeling	Conducting performance appraisals	Groups B and C had higher test scores (knowledge) than Group A; Group C had higher behavioral performance ratings (skill) than either Group A or B.

trainee's performance. The Davis and Mount study results showed that CAI—with or without behavioral modeling—had the greatest influence on knowledge, as measured by paper-and-pencil tests. However, managers in the CAI/behavior modeling group showed significantly more *skill* in conducting performance appraisal discussions, as measured by behavioral (role-play) ratings. Further, employees of these managers expressed significantly greater satisfaction with the appraisal system and with feedback interviews conducted by their managers.[6]

A consistent pattern emerges from these studies. When acquiring factual knowledge is the training objective, adding visuals to CAI has little benefit. However, when the objective pertains to performance or behavior, the addition of a visual image is beneficial. Graphics, in most cases, should be used for behavior/performance training, rather than knowledge training.

One step further to efficiency

By focusing on the technology necessary for adequate instruction, expensive frills, which add little or nothing to training effectiveness, are eliminated. Faddish techniques and flashy nice-to-haves should be disregarded. But relatively expensive training technology with documented effectiveness should not be dismissed arbitrarily as fad and fancy. Discussions must be based on whether the effectiveness gain is worth the added cost.

With a little ingenuity, substitute methods may significantly reduce costs without chipping away at effectiveness. A programmed text, for example, is much less expensive to develop and produce than either CAI or interactive video. Therefore, unless there are significant differences in training effectiveness, the text should be used. Expensive, professionally drawn graphics or photographs might be replaced by having students view the object itself. In behavior training, the filmed or videotaped model—usually an actor following a carefully prepared script—might be replaced by a well-rehearsed live model who actually is a trainer.

There's another way to reduce CAI training costs. Noting that the student/terminal ratio in CAI is typically 1:1, a 1983 study investigated peer training, a strategy in which two students train jointly at a single terminal. In the first of the two-part study, student achievement and training times were compared for: (a) peer instruction via CAI; (b) individual instruction via CAI; and (c) conventional classroom training (see Table 2). The CAI training materials were prepared by regular classroom instructors who were given only limited training in CAI authoring techniques. The results indicated no differences in training effectiveness. This was attributed to the highly structured nature of the classroom training. (It was

Table 2—Training Effectiveness Studies Using Peer Training in CAI

Study	Training Conditions	Results
Dossett and Hulvershorn (Part 1)	A. CAI peer training B. CAI individual training C. Conventional classroom training	No significant differences in test scores. Individual CAI training time 37 percent less than conventional classroom; CAI peer training time 20 percent less than CAI individual time. Peer training time significantly less variable than individual CAI training time.
Dossett and Hulvershorn (Part 2)	Students of varying ability levels (i.e., very low, below-average, above-average, very high) systematically paired during training	Examination scores equivalent regardless of CAI partner's ability level. Homogeneous pairs of high or above-average ability had shortest training times. Below-average students paired with very high ability partners also had lower training times.

a military class.) Training times, however, were affected significantly by CAI training. In addition to lower training times, peer training produced more predictable training times.

The implications of reduced training time become especially important when trainees are paid and terminal availability is limited. The lowered variability of training time also is important for cost-efficient scheduling of training facilities.

The second part of the study determined the effects of pairing students of varied abilities on training time and student achievement. The students were trained via CAI. They also engaged in off-line training exercises (e.g., measuring resistance in an electrical circuit) and took examinations individually. The study found that the ability level of one's partner in training had no effect on individual examination scores. Training times, however, were affected markedly. So were student/instructor contact times. Very high ability students apparently acted as effective tutors for below-average and very low ability partners. This was proven by very low instructor contact times.

The study concluded that pairing very low ability students was beneficial to both training and instructor contact time. Pairing slightly below-average students, on the other hand, with very high ability partners saved time without reducing training effectiveness. Overall, there was a 51 percent reduction in training time. Student/instructor contact time averaged less than two percent of total training time. Trainee responses were extremely favorable. One trainee commented, "You have three people helping you—your partner, the instructor and the computer—while in the classroom you only have one."[7]

These studies tell us several things:

- Subject-matter experts, such as classroom instructors, can prepare CAI training materials after only minimal training in CAI authoring techniques. Thus, a staff of computer experts and educational psychologists is not necessarily a prerequisite for developing sound CAI programs.
- CAI is *at least* as effective as conventional classroom or programmed instruction.
- Student/instructor contact times of less than five percent imply greater availability of instructors for individualized help. With CAI, the instructor's role may shift from classroom lecturer to training manager, broadening his or her activities and responsibilities. Students can be trained by a smaller instructional staff—especially with peer training—thus decreasing staff salary/overhead costs per student.
- Shorter training times resulting from peer training translate directly into increased efficiency; training costs are lower and a greater number of graduates qualify for work assignments in a shorter period of time.
- CAI makes using remote facilities and on-the-job training easier. The computers involved are small and transportable, and the demands for instructor attention are low. Decentralizing training sites, especially, contributes much to the reduction of training costs.

Neither cutting-edge nor conventional instruction is the right choice for all training demands. A close look at the learning tasks and learner abilities at hand will reveal the most appropriate, most productive method for your specific needs.

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