Strategy Training: An Incidental Learning Model for CAI

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Abstract. Attempts to train learning strategies have not produced marked or lasting increases in academic achievement probably because current training models fail to recognize the evolutionary nature of strategies acquisition. Empirical and theoretical evidence is presented supporting an incidental learning model that engineers the instructional environment following study skills training, so that students are prompted to recall and use strategies during study. At onset of spontaneous strategies initiation, prompts are faded gradually, to produce automatic processing. The model can be implemented on a very large scale as CAI, or as a somewhat less promising paper curriculum.

My students and I began this work last year with a review of literature pertaining to the training of what Brown and Campione (1982) have called the "skills of academic intelligence"—learning strategies. Here the term *learning strategy* refers to the mental operations that a student employs in an instructional situation to acquire different kinds of knowledge and performance. Thus conceived, learning strategies lie within the domain of *cognitive strategies* (Bruner, Goodnow & Austin, 1956; Gagne, 1980a, 1980b), a broader family of capabilities that enables individuals to exercise control over their own intellectual processes.

Seven types of learning strategies that might be taught to adults with academic deficiencies were identified: mood management, attentional management, memorization strategies, reading strategies, problem-solving strategies, test-taking strategies, and vocabulary learning strategies. A number of researchers (e.g., Dansereau, Collins, McDonald, Holley, Garland, Diekhoff, & Evans, 1979; McCombs & Dobrovolny, 1982; Weinstein, 1978, 1979; Rood & Weinstein, 1983) have developed study skills courses offering direct training in these skills, and have reported modest improvements in students' abilities to learn, remember, and solve problems. However, study skills training has not yet produced marked or lasting increases in academic achievement, possibly because current training models do not recognize the evolutionary nature of strategies acquisition. Research and theory suggest that thinking skills must be developed *gradually*, as by-products of practice and experience.

Gagne (1980a) also has expressed doubt that strategic thinking can be "trained" in the usual sense of the word. He points out the enormous diversity of task-specific cognitive strategies, and the experiential aspects of their natural evolution. Thinking skills, he argues, are adaptive intellectual capabilities that evolve slowly through contact with many different learning situations. If this is true, then study skills training would not be likely to provide the rigorous and extended practice that is needed in order for learning skills to develop. To achieve training of strategies, an elaborate curriculum plan that recognizes and accommodates the evolutionary aspects of strategies acquisition must be devised.

This paper describes a strategies training model that attempts to "engineer" the instructional environment following study skills training, so that students are prompted to invoke and use previously taught learning strategies during study. My discussion here develops a rationale for our approach, which is consistent with research on incidental learning

(Craik & Lockhart, 1972; Craik & Tulving, 1975), follows Sternberg's (1983) guidelines for intellectual skills training, and is congruous with what Gagne (1980) has written about how cognitive strategies are acquired. This training model is ideal for large-scale implementation as CAI, or as a somewhat less promising paper curriculum. In a CAI implementation, the computer collects data on each student to help determine the onset of spontaneous strategies initiation, at which time prompts are phased out.

A large-scale basic skills curriculum that incorporates this model is currently being developed for the Army at Florida State University's Center for Educational Technology. This curriculum, called the Job Skills Education Program (JSEP), is scheduled for tryout in 1986 at several Army posts. My colleagues and I have designed strategies training and a prompting system that will interact with a CAI version of the JSEP curriculum. One feature of the design is an introductory learning strategies course offering direct training in: (a) the use of a general learning strategy for approaching basic-skills computer-based instruction, and (b) a variety of simple component strategies that can be used to accomplish the general strategy.

A second feature of the JSEP design is a prompting system, embedded within the basic skills lessons, that (a) reminds students, at appropriate times, to invoke and utilize strategies; (b) gradually phases out prompts in advanced stages of instruction, when there is sufficient evidence of spontaneous strategies initiation.

We have engineered the system so that basic skills lessons can be offered with the prompting system either on, off, or partially deactivated. Thus, it is possible to compare versions of the JSEP program that incorporate various components of the strategies training model, with a control curriculum that contains neither strategies training nor a prompting system.

We hypothesize that the full training model can produce significant increases in academic achievement, as measured by standardized assessment procedures. However, legitimate increases in achievement are predicted only for those students who participate in JSEP on a regular schedule for a lengthy period of time—six months or more. Additional research must be conducted to determine the necessary frequency and duration of treatment, which could vary greatly, depending upon a student's entering competencies.

Strategies Initiation: Awareness and Control

One feature of JSEP that distinguishes it from previous basic skills curricula (e.g., McFann Gray, Science Research Associates) is that JSEP attempts to develop student awareness and control of strategic learning ability. Derry and Murphy (in press) have discussed how initiation and control of learning strategies may arise primarily from the student's own self-instructions (learner-controlled), or from an instructional system (lesson-controlled). Following Rigney (1978, 1980), they conceptualize a continuum ranging from conscious to subconscious processing, and point out how student awareness can vary along this continuum.

A *conscious* strategy is described independently of the subject matter; the student is aware of its existence in a "metacognitive" (Brown, 1978, 1980) sense. A *subconscious* strategy may be lesson-controlled if it is deliberately "forced" by the instructional design, or student-controlled if it is not. In either case, the learner is not spontaneously aware of its use. Suggested are the four conceptualizations of learner strategies presented in Figure 1.

Figure 1. Four Types of Learning Strategies

Learner Awareness of Strategy	Student Controlled	Lesson Controlled
Conscious	A	B
Subconscious	C	D

For example, consider a student attempting to learn the text material in a training manual. If the student consciously adopts the use of paraphrase, imagery, and self-generated questions, this would be an example of situation A. But, if the textbook directly instructs the student in the use of this strategy, this would exemplify B. Rigney's (1978, 1980) premise was that combination A of Figure 1 is desirable. He argued that when students have not naturally acquired appropriate strategies for learning, situation A might be realized through implementation of situation B. In early phases of training, instruction would explicitly point out that there are strategies that can be applied to facilitate learning of the subject content. As the student progresses and develops greater skill with the subject, strategy training can be phased out, leading ultimately to situation A.

Situation C is illustrated by the combination in which the student has evolved, through experience with a particular type of material, a processing method that is so spontaneous and automatic, there is no conscious awareness of its initiation and use. The widely accepted resource allocation model of attention (Norman & Bobrow, 1975) suggests that automaticity is a highly desirable long-range goal for strategies training. Automatic strategies initiation is believed to free attentional resources that can be devoted to processing of content based instruction.

Derry and Murphy (in press) point out that no training system has yet achieved combination C. Rigney (1980) suggested that extended practice of a newly acquired strategy, as in situation A, could help develop the type of automaticity that is a desirable characteristic of the subconscious student controlled strategy. Another theorist (Brown, 1980) also has proposed that one route to automatic processing is through initial training in "metacognitive awareness." JSEP will attempt to engineer spontaneous initiation of new strategies, by moving the student from conscious, lesson-controlled processing, through what might be termed the metacognitive phase, toward a smoother, more automatic form of processing. The success of this approach is an empirical issue that has not yet been resolved.

In contrast to the JSEP approach, most basic skills curricula represent situation D, the lesson-controlled counterpart to automatic processing. This instructional design methodology involves incorporating controls into a lesson, so that students are required to employ particular processing strategies in order to accomplish subject-matter orienting tasks. For example, inserted questions (Anderson & Biddle, 1975; Andre, 1979; Rickards, 1976) may be used to foster imaging and depth processing. Or, through explanation techniques based on metaphor and analogy (Ortony, 1975; Rumelhart & Norman, 1981), or the advance organizer (Ausubel, 1963; Ausubel, Novak & Hanesian, 1978), students might be required to encode new information in the context of a particular prior knowledge structure. In the field of instructional development, current standards are dominated by the methodologies of Gagne & Briggs (Briggs, 1977; Gagne, 1977; Gagne & Briggs, 1974), which rely on subconscious, lesson-controlled strategies supplied by the instructional designer as part of an event called "learning guidance."

The effects of lesson-controlled strategies have now been documented by a substantial body of literature, yet our review of that literature reveals few, if any, totally dependable instructional techniques. With the possible exception of "forced" practice-and-feedback, no single, isolated instructional device that will greatly enhance instructional effectiveness is known. By contrast, some explicitly taught learner-controlled techniques, such as mnemonics and pegword systems, have significantly enhanced memory, at least for lists and paired associates (Bower, 1970).

Furthermore, Rigney (1978) has argued that hidden strategies do little to help the student cope with requirements for further independent learning of material that is not highly "designed,"—a technical manual accompanying electronic equipment, for example. Yet, the notion of subconscious, lesson-controlled strategies has strong intuitive and theoretical appeal. If thought control can totally be relinquished by the student to the instructional system, more of the learner's activation resources presumably are available for concentrated processing of subject-matter material. Thus, it might be argued that situation D represents the most efficient form of instruction, when strategies acquisition is not an important instructional goal.

Cognitive Strategies, Intellectual Skills, and Cognitive Style

Gagne (1977) has defined five types of subject-matter for which a training curriculum can be developed:

1. cognitive strategies,
2. intellectual skills,
3. verbal information,
4. motor skills, and
5. attitudes.

In Gagne's terminology, JSEP represents an intellectual skills curriculum. Soldiers enter JSEP to acquire the prerequisite math and verbal competencies that will enable them to learn their military tasks. However, it is necessary in this context to make an important distinction between Gagne's conceptualization of *intellectual skills training*, and another well-known use of this same phrase, derived largely from theories of intelligence and popularized by Sternberg.

Gagne (1977) has identified five progressively complex classes of intellectual skills: discriminations, concrete concepts, defined concepts, rules, and higher-order rules. To acquire the skill of "making change," for example, the student first must be able to distinguish coin types from one another, and to identify them by name and monetary value. The rules of addition, subtraction, and monetary equivalence also must be acquired. These concepts and rules, which are identified by a cognitive task analysis of the to-be-learned operation, become either the prerequisite competencies or the subject-matter objectives for a skill lesson.

This subject matter does *not* include direct training in how to conduct the cognitive processes actually involved in making the discriminations, acquiring concepts, or committing rules to memory. The instruction is designed to facilitate, rather than teach or explain, the learning process.

In contrast, the purpose of *intellectual skills training*, as implied by Sternberg's (1983) use of the phrase, is to improve the processing intelligence of the learner. Sternberg has developed a method for isolating elemental component thinking processes that underlie various types of skilled performance, and has suggested guidelines for design of process-oriented training to improve the speed and facility with which the learner carries out actual thinking operations.

Intelligence training has two aims: (a) to sharpen the learner's component processing abilities, and (b) to improve the learner's ability to formulate higher-order *cognitive strategies*, which combine component processes.
Intensive practice has supplied an important key in the training of component processes. Frederickson (1983), for example, has developed intelligent computer games that successfully improve components underlying reading skill, such as letter-group perception speed, through continuous computer-controlled practice and feedback. Practice also plays a key role in the evolution of higher-order cognitive strategies. However, strategies development calls for a more programmatic training approach that supplies highly varied practice over an extended period of time.

A serious shortcoming of study skills courses is that they are unable to supply a real world context for long term varied practice in strategies formulation.

Sternberg's notion of the *intellectual skill* differs from Gagne's, but is more than roughly equivalent to Gagne's notion of "cognitive strategy." (From Gagne's point of view, one of Sternberg's "component processes" would amount to no less than a prerequisite competency for acquiring a particular cognitive strategy.) Here we will follow Gagne's (1977, 1980a) convention of distinguishing between *cognitive strategy* and *intellectual skill* as two distinctly different forms of human capability. This distinction already is well-established in the field of instructional design, and it helps clarify the nature of the JSEP model, which embeds cognitive strategies training within an intellectual skills curriculum.

The parallel between Gagne's notion of cognitive strategy and Sternberg's view of intelligence is emphasized, to make the point that in many respects the JSEP approach to strategies training adheres to Sternberg's 1983 guidelines for training the intelligence. In this sense, it might be argued that JSEP represents a large-scale, programmatic effort to improve a form of *processing intelligence* —ability to learn from a particular type of training system.

We must note that currently there is a trend toward differentiating the concept of *processing intelligence* from that of *cognitive style. Cognitive styles* have been defined as *non-evaluative* individual differences in modes of conducting thinking processes such as perceiving, attending, storing, remembering, transforming, and utilizing information. The notion of intellectual ability concerns processing *capacity*, which can vary on an evaluative continuum from low to high (Federico, 1980).

Because the JSEP introductory course includes direct, step-by-step instruction in processing mode, it could be argued that strategies training in JSEP is more appropriately described as an attempt to alter cognitive style rather than intelligence. We prefer the concept of *cognitive strategy*, and the idea that strategy can be taught as a means of obtaining more efficient and intelligent use of processing resources that may, in fact, be relatively limited. In this context, we draw no evaluative distinction between "intelligence" that results from efficient use of limited capacity resources, and that resulting from a larger resource allotment and less effectual strategy.

Embedding a Strategies Training Program

Sternberg's (1983) guidelines for improving intelligence (as measured by standardized aptitude tests) emphasize the importance of providing appropriate linkages between the processing skills that are being taught and real-world processing situations. Learners often are required to process, during training, the types of materials they will encounter in their daily experience. For example, Sternberg notes that one of his programs trains the set of skills individuals use to learn the meanings of previously unknown words. If a job-relevant vocabulary list were employed during training, then students not only would acquire the ability to figure out the meanings of new words, but also may acquire, as incidental learning, a vocabulary list that is personally relevant. As pointed out by Derry and Murphy (in press), this approach amounts to embedding, within a strategies training program, secondary objectives based on what usually is regarded as the primary subject-matter in a functional basic skills curriculum.

Improving a person's ability to function within a standardized instructional environment is a viable goal.

These authors argue that learning strategies programs have usually treated academic subject-matter as practice material. The typical approach is represented by the adjunct study-skills courses developed by McCombs (1983), Dansereau et al. (1979), and Weinstein (1978, 1979). These programs are standalone curricula in which strategies acquisition, rather than subject-matter learning, is the primary aim. They teach and provide practice in using general processing and self-management schemes that are "detached" (Rigney, 1980) from any particular curriculum, but, presumably are applicable to a wide variety of learning situations. Study-skills courses have produced statistically significant (though modest) gains in student attitude, motivation, confidence, and in certain types of school performance measures (Vaughan, 1981). A serious shortcoming of study skills courses is that they are unable to supply a real-world context for long-term, varied practice in strategies formulation.

Jones (1983) has argued in favor of embedded strategies training, which offers instruction and practice in learning strategies totally within the context of a curriculum based on subject-matter learning goals. Her approach incorporates explicit instructions on text processing strategy into subject-matter instructional materials received by teachers and students. One advantage to this approach is that it can be implemented without extensive in-service teacher training. Four types of strategies instruction can be embedded:

1. **Step-by-Step Prompts,** complex, multi-step thinking directions,
2. **Think Aloud Models,** simulated dialogues of a model student processing a portion of text,
3. **Adjunct Study Questions,** which require particular thinking processes, and
4. **Study Prompts,** reminders to use specific information processing strategies that have been taught previously.

Jones and her associates have developed several large-scale embedded strategies curricula that rely heavily on the first three types of embedded instructions, especially the step-by-step prompts. Jones' approach can be contrasted with that taken in JSEP, which is based on a less obtrusive prompting method.

When nonobtrusive study prompts are employed, step-by-step strategies training occurs outside the actual learning event rather than in conjunction with subject-matter instruction. Brief reminders to use previously learned strategies are then inserted, at appropriate points, into lessons based on more traditional subject-matter material. This prompting method is unique in that it encourages practice in the recall, as well as the use, of previously acquired learning strategies. Thus, it is more likely to encourage the development of independent processing.

Furthermore, since step-by-step strategies training is provided outside the actual learning event rather than in conjunction with subject-matter instruction, study prompts are less likely to disrupt concentration. Nonobtrusive prompts are a feature of the JSEP model, which treats strategies development as a form of incidental learning embedded within a functional basic skills curriculum. Empirical and theoretical justification for the incidental strategies training approach is supplied in part by research based on the depth-of-processing paradigm (Craik & Lockhart, 1972; Craik & Tulving, 1975), which clearly has demonstrated that intention to learn is not a prerequisite for actually learning.

Metastrategies and Component Strategies

A learning strategy has been conceived by Dansereau (1978) as a mental construction that embodies both a situationally-relevant general metastrategy, and groups of component substrategies that are associated with the metastrategy. To initiate a strategy for learning, an individual must not only access an available library of component processing skills, but also select particular component processes, organize them into a metastrategy that matches a particular learning situation, and continuously monitor the success of the learning effort. The relationship between a metastrategy and its related substrategies parallels the link between what Sternberg (1983) has called "executive" and "nonexecutive" information processing routines. He argues that programs which attempt to train a form of intelligence " . . . should provide explicit training in both executive and nonexecutive information processing, as well as interactions between the two kinds of information processing" (Sternberg, 1983, p. 9).

We conclude that strategies training systems should teach not only essential component cognitive skills, but also a repertoire of metastrategies appropriate for frequently encountered learning situations. For example, Dansereau and his associates have taught college students to utilize *MURDER*, a mnemonic which stands for a sequence of steps in a general study strategy — set your Mood, read for Understanding, Recall, Digest information (correct recall, amplify and store), Expand knowledge through self-inquiry, and Review mistakes. A simple variation on this mnemonic is taught as a general heuristic for test-taking. Specific component processing skills associated with each step in these mnemonics also are taught: mood-setting may involve positive self-talk and progressive relaxation; amplification could be accomplished through imaging or paraphrasing.

When considered alone, a metastrategy that is general enough to be used for many types of lessons and curricula amounts to what Newell (1980) has called a "weak" strategy. The method is weak because it trades power for generality. However, when coordinated with embedded prompts to engage various specific processing techniques to accomplish a metastrategy, the technique becomes a model for training students in what Newell has called a "Weak to Strong Method Sequence." "The weak methods can be taken to be just the tip of the iceberg, so that there exists an expanding cone of methods of ever greater specificity and power. This is a variant of the Big Switch hypothesis, for at the base of the cone are the multitude of specific expert procedures" (Newell, 1980, p. 186).

We hypothesize that acquisition of a metastrategy will provide learners with an important link insuring continued initiation of component strategies, even after explicit prompts are deleted. A well established fact of memory research is that recall of high-order contextual categories effectively cues even long "forgotten" specific memories (Tulving, 1974; Marslen-Wilson & Teuber, 1975). In the same sense, recall and initiation of a simple, general response to an instructional situation could continue to cue an available library of more specific processing techniques. But, although the metastrategy technique provides a useful method for initially introducing students to the concept of learning strategies, as a training method it will prove insufficient unless followed by opportunity for frequent practice within a curriculum that supplies an appropriate semantic context for strategies use and generalization.

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The JSEP Strategies Training Program

An example of how adjunct strategies training, the metastrategy technique, and nonobtrusive prompting can be combined in a CAI curriculum is illustrated, again with reference to JSEP. JSEP begins with an introductory learning strategies course consisting of two units: "Welcome to JSEP," and "Learning Skills You Need for JSEP." One lesson in the welcome unit, entitled "What JSEP lessons are Like," will suggest that students employ a general metastrategy for approaching every basic skills lesson.

The metastrategy consists of five elements:

1. Control your mood,
2. Set your goal and pace,
3. Memorize when necessary,
4. Employ a reading strategy, and
5. Practice thoughtfully.

Each element of this metastrategy is introduced by a fictitious character whose image and name represents his or her particular concept. In further introductory lessons, specific *component strategies* that can be initiated by the learner to accomplish each metastrategy step are taught by the appropriate character. For example, problem solving strategies are introduced by a character modeled after Sherlock Holmes. In the final segment of the introductory course, entitled "Making Your Skills Work Together," the characters are pictured in scenes together so that they will become associated with one another as members of a cooperating group. The intent of this device is to create an "imagery mnemonic" that will cue students when they attempt to recall elements in the metastrategy.

These characters also will appear often within the basic skills lessons that compose most of the JSEP curriculum. Within the lessons, they will function as part of a prompting system that analyzes student responses to determine whether or not the metastrategy is being utilized, and encourages soldiers, when necessary, to consciously recall and employ their new learning skills. For example, students who are actively practicing the skill of comprehension monitoring will frequently use the review option for difficult-to-understand material. If results of a comprehension posttest indicates lack of understanding, but the review counter has posted few or no reviews for that student, then a prompting character would begin to appear, encouraging use of the review option. This prompting procedure is analogous to establishing, in a problem-solving situation, what Bower (1975) and Gagne (1980) have called a learner set. "The effect of the set is to activate a cognitive strategy that persists during the time the processes of problem solving are being employed" (Gagne, 1980, p. 15).

One important difference between the JSEP system and most other forms of strategies training, particularly study-skills courses, is the attention paid by the former to development of automaticity. Most strategies training programs begin by raising the student's metacognitive consciousness. But, the embedded model implemented in JSEP further attempts to logistically engineer the change from the laborious activity of the conscious level to the ". . . normal rapid automatic pilot state . . . "that distinguishes subconscious processing (Brown, 1980).

Throughout the instructional program, students who need prompts are reminded to engage in the extensive and rigorous strategies practice that is known to be necessary for the development of automatic processing (Hirst, Spelke, Reaves, Caharack and Neisser, 1980; Neisser, 1976; Rigney, 1980), or at least smooth performance. With the onset of spontaneous strategies initiation, reviews and prompts can be phased out, presumably in advanced stages of instruction.

The JSEP Taxonomy

The task of creating a strategies training program requires a taxonomy of curriculum-relevant component strategies. Gagne (1980) has argued that the universe of cognitive strategies is so diverse that it is virtually unteachable. However, when training of strategies is contextualized within the bounds of a metastrategy that has been chosen to fit a particular subject-matter curriculum, the burden of identifying a relevant set of component strategies is substantially eased.

A taxonomy of component strategies was created specifically for JSEP. The JSEP taxonomy represents a synthesis of ideas borrowed from organizational frameworks created by Dansereau and his colleagues (1978), McCombs (1983), Weinstein (1978, 1979, Rood & Weinstein, 1983) and Vaughan (1981), as well as the authors' recent review of strategies literature.

The JSEP taxonomy is organized into five categories compatible with the previously discussed metastrategy:

1. Mood management techniques,
2. Self-pacing methods,
3. Comprehension strategies,
4. Memory strategies, and
5. Problem solving techniques.

Mood management strategies, derived largely from the clinical literature of Meichenbaum (1977) and others, are techniques that can help students establish a constructive attitude early in a lesson, and maintain it throughout the instructional event. Mood management embodies positive self-talk, cognitive restructuring, and methods for reducing test anxiety and maintaining a high level of concentration. The self-pacing strategies are behavioral self-management "tricks," including techniques for setting and meeting realistic goals, time scheduling, self-contracting and self-reinforcement. The goal of the self-pacing training is to enhance attentional processes by gradually increasing time on task within the learning center. Strategies in the self-pacing and mood-management categories are similar to those listed by Dansereau as "support strategies." They are similar also to strategies incorporated by McCombs into her "motivational curriculum."

Strategies for reading, skilled memory, and problem solving are "primary information processing strategies" in Dansereau's terminology, although his taxonomy does not include the problem-solving category. Reading strategies training in JSEP will be based on the ideas of Brown (1980), Cook and Mayer (1983), and Collins and Smith (1982). Students will be taught three types of reading techniques: how to select a strategy, how to monitor comprehension, and what remedial steps should be taken when comprehension failure occurs.

Over fifty percent of the strategies training in JSEP will be devoted to reading, memory, and problem-solving strategies. These categories raise controversial issues related to their role in skills acquisition, and have been discussed elsewhere in some detail (Derry & Murphy, in press). The memory module will teach the concepts of active memory and executive decision-making. In addition, three types of specific memory strategies (mnemonics) will be taught: strategies for learning single words and ideas, techniques for list-learning, and strategies for connected discourse. The problem-solving module will teach specific methods that can be used to help solve word problems involving arithmetic and mathematics operations. Students will learn to clarify a problem (schema training), to develop different solution methods, and to evaluate their answers by using "common sense" criteria. In a supplementary module, problem solving training will be generalized to cover test-taking situations.

Incidental Strategies Training and the Principles of Instructional Design

As used in JSEP, the metastrategy technique requires that content-based lessons that make up the curriculum are

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structurally compatible with one another and with the metastrategy. At the very least, lesson structures and the student's metastrategy should not operate in conflict. Many JSEP lessons were designed according to methods advocated by Gagne and Briggs (Briggs, 1977; Gagne & Briggs, 1974). Thus, it was necessary to adopt a metastrategy that could be mapped upon the Gagne and Briggs events of instruction. The important point is that addition of student-controlled strategies to the instructional situation need not eliminate the use of instructional design principles that depend upon hidden controls.

JSEP students are taught strategies that should enhance the effectiveness of the instructional system. Consider, for example, the combined effectiveness of a designer's use of color to highlight key ideas, and a student's deliberate attempt to locate and encode key concepts. Whether or not the addition of an introductory course, metastrategies training, embedded prompts, or some combination of these significantly enhances learning over and above what is attained from well designed instruction alone is an important issue that should be addressed in future research.

It could be true that when strategies training is tied to a particular instructional system that has been thoughtfully sequenced and designed, learners will become system-dependent—unable to transfer learning skills into new situations that require them to deal with less adequate instructional conditions. Jones (1983) points out that strategies useful in one text design condition may be useless in another. However, training implemented within the context of a "text adequate" (Jones, 1983) curriculum may transfer to other learning situations that could be described as "text inadequate," provided strategies for transfer into simulated real-world problem situations are taught and practiced during training. The viability of this approach to transfer of strategies training also must be examined experimentally. But, even if transfer of strategies training proves to be limited, it is reasonable to assume that in many environments, instructional design is or could be standardized, at least for low-ability students. Improving a person's ability to function within a standardized instructional environment, or with a standard design for training manuals, is a viable goal, and currently may be the best possible approach for basic skills training within military services, school districts, and industrial organizations with large-scale training needs.

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References

Anderson, R. C., & Biddle, W. B. (1975). On asking people questions about what they are reading. In G. Bower (Ed.), *Psychology of learning and motivation, 9* (pp. 89-132). New York: Academic Press.

Andre, T. (1979). Does answering higher-level questions while reading facilitate productive learning? *Review of Educational Research, 49(2), 280-318.*

Ausubel, D. P. (1963). The psychology of meaningful verbal learning: An introduction to school learning. New York: Grune & Stratton.

Ausubel, D. P., Novak, J. D., & Hanesian, H. (1978). *Educational psychology: A cognitive view* (2nd ed.). New York: Holt, Rinehart, and Winston.

Bower, G. H. (1970). Analysis of a mnemonic device. *American Scientist, 58,* 496-510.

Bower, G. H. (1975). Cognitive psychology: An introduction. In W. K. Estes (Ed.), *Handbook of learning & cognitive processes,* Vol. 1 (pp. 25-80). Hillsdale, NJ: Erlbaum.

Briggs, L. J. (1977). *Instructional design: Principles and applications.* Englewood Cliffs, New Jersey: Educational Technology Publications.

Brown, A. (1978). Knowing when, where and how to remember: A problem of metacognition. In R. Glaser (Ed.), *Advances in instructional psychology* (Vol. 1) (pp. 77-165). Hillsdale, New Jersey: Erlbaum.

Brown, A. (1980). Metacognitive development and reading. In R. J. Spiro, B. C. Bruce & W. F. Brewer (Eds.), *Theoretical issues in reading comprehension* (pp. 453-481). Hillsdale, NJ: Erlbaum.

Brown, A. L., & Campione, J. C. (1982). Modifying intelligence or modifying cognitive skills: More than a semantic quibble? In D. K. Detterman & R. J. Sternberg (Eds.), *How and how much can intelligence be increased* (pp. 215-229). Norwood, NJ: ABLEX.

Bruner, J. S., Goodnow, J. J., & Austin, G. A. (1956). *A study of thinking.* New York: Wiley.

Cermak, L. S., & Craik, F. I. M. (Eds.) (1979). *Levels of processing in human memory.* Hillsdale, New Jersey: Erlbaum.

Collins, A. & Smith, E. C. (1982). Teaching the process of reading comprehension. In D. K. Detterman & R. J. Sternberg (Eds.) *How and how much can intelligence be increased* (pp. 173-186). Hillsdale, NJ: Erlbaum.

Cook, L. K., & Mayer, R. E. (1983). Reading strategies training for meaningful learning from prose. In M. Pressley & J. R. Levin (Eds.), *Cognitive strategy research: Educational applications* (pp. 87-126). New York: Springer-Verlag.

Craik, F. I. M., & Lockhart, R. S. (1972). Levels of processing: A framework memory research. *Journal of Verbal Learning and Verbal Behavior, 11,* 671-684.

Craik, F. I. M., & Tulving, E. (1975). Depth of processing and the retention words in episodic memory. *Journal of Experimental Psychology: General, 104,* 268-294.

Dansereau, D. F. (1978). The development of a learning strategy curriculum. In H. F. O'Neill, Jr. (Ed.), *Learning strategies* (pp. 1-29). New York: Academic Press.

Dansereau, D. F., Collins, K. W., McDonald, B. A., Diekhoff, G., Garland, J., Holley, C. S., Evans, S. H., Irons, D., Long, G., Walker, C., Hilton, T., Lehman, D., Halemanu, M., Ellis, A. M., & Fenker, R. M. (1978). *Systematic training program for enhancing learning strategies and skills: Further development* (AFHRL-TR-78-63). Lowry Air Force Base, Colorado: Air Force Human Resources Laboratory, Technical Training Division, September.

Dansereau, D. F., Collins, K. W., McDonald, B. A., Holley, C. D., Garland, J. C., Diekhoff, G. M., & Evans, S. H. (1979). Development and evaluation of an effective learning strategy program. *Journal of Educational Psychology, 79(1), 64-73.*

Derry, S. J., & Murphy, D. (in press). Designing systems that train learning ability: From theory to practice. *Review of Educational Research.*

Federico, Pat-Anthony. (1980). Adaptive instruction: Trends and issues. R. E. Snow, Federico, P. & Montague, W. E. (Eds.), *Aptitude, learning & instruction* (Vol. 1) (pp. 1-26). Hillsdale, N. J.: Erlbaum.

Fredericksen, J. R. (1983). Computer games for training critical reading skills. Presentation, AERA, Montreal, Canada, 1983.

Gagne, R. M. (1977). *The conditions of learning* (3rd ed.). New York: Holt, Rinehart, and Winston.

Gagne, R. M. (1980a). Learnable aspects of human thinking. In A. E. Lawson (Ed.), *The psychology of teaching for thinking and creativity.* 1980 Yearbook, Association for the Education of Teachers in Science. Columbus, Ohio: ERIC Clearing House For Science, Mathematics, & Environmental Education, Ohio State U.

Gagne, R. M. (1980b). Learnable aspects of problem solving. *Educational Psychologist, 15(2), 84-92.*

Gagne, R. M., & Briggs, L. J. (1974). *Principles of instructional design.* New York: Holt, Rinehart, & Winston.

Hirst, W., Spelke, E. S., Reaves, C. C., Caharack, G., & Neisser, U. (1980). Dividing attention without alteration or automaticity. *Journal of Experimental Psychology: General, 109,* 98-117.

Jones, B. F. (1983). *Integrating learning strategies and text research to teach high order thinking skills in schools.* Presentation, AERA, Montreal, Canada.

Marslen-Wilson, W. D., & Teuber, H. L. (1975). Memory for remote events in anterograde amnesia: Recognition of public figures from newsphotographs. *Neuropsychologia, 13,* 353-364.

McCombs, B. (1983). *Motivational skills training: Helping students adapt by taking personal responsibilities and positive self-control.* Presentation, AERA, Montreal, Canada.

McCombs, B. L., & Dobrovolny, J. L. (1982). *Student motivational skill training package: Evalua-*

tion for air force technical training (AFHRL-TP-82-31). Lowry Air Force Base, Colorado: Logistics and Technical Training Division, December.

Meichenbaum, D. H. (1977). *Cognitive behavior modification: An integrative approach*. New York: Plenum Press.

Meichenbaum, D. H., & Cameron, R. (1974). In M. J. Mahoney, & C. E. Thoresen (Eds.), *Self-control: Power to the person* (pp. 263-358). Monterey, CA.: Brooks-Cole Publishing.

Neisser, U. (1976). *Cognition and reality*. San Francisco: Freeman.

Newell, A. (1980). One final word. In D. T. Tuma & F. Reif (Eds.) *Problem solving and education*. (pp. 184-187). Hillsdale, NJ: Erlbaum.

Norman, D. A. & Bobrow, D. G. (1975). On data-limited and resource-limited processes. *Cognitive Psychology, 7*, 44-64.

Ortony, A. (1975). Why metaphors are necessary and not just nice. *Educational Theory, 25*, 45-53.

Rickards, J. P. (1976). Stimulating high-level comprehension by interspersing questions in text passages. *Educational Technology*, November, 13-17.

Rigney, J. W. (1978). Learning strategies: A theoretical perspective. In H. F. O'Neil, Jr. (Ed.), *Learning strategies* (pp. 165-205). New York: Academic Press.

Rigney, J. W. (1980). Cognitive learning strategies and dualities in information processing. In R. E. Snow, P. Federico & W. E. Montague (Eds.), *Aptitude, learning, and instruction* (Vol. 1) (pp. 315-343). Hillsdale, NJ: Erlbaum.

Rood, M. M., & Weinstein, C. E. (1983). Improving higher-order learning skills: elaborative cognitive learner strategies training. Presentation, AERA, Montreal, Canada.

Rumelhart, D. E., & Norman, D. A. (1981). Analogical processes in learning. In J. R. Anderson (Ed.) *Cognitive skills and their acquisition* (pp. 335-359). Hillsdale, NJ: Erlbaum.

Sternberg, R. J. (1983). Criteria for intellectual skills training. *Educational Researcher, 12(2), 6-12.*

Tulving, E. (1974). Cue-dependent forgetting. *American Scientist, 62, 74-82.*

Vaughan, E. (1981) *Cognitive strategies: A review of some recent literature*. (Contract No.: DABT60-81-C-006). U.S. Army Training Support Center.

Weinstein, C. E. (1978). Elaboration skills as a learning strategy. In H. F. O'Neil Jr. (Ed.), *Learning strategies* (pp. 31-55). ?New York: Academic Press.

Weinstein, C. E., Underwood, V. L., Wicker, F. W., & Cubberly, W. E. (1979). Cognitive learning strategies: Verbal and imaginal elaboration. In H. F. O'Neil & C. D. Spielberger, (Eds.), *Cognitive and affective learning strategies* (pp. 45-75). New York: Academic Press.