A STRATEGY MODEL FOR COMPUTER BASED TRAINING

William A. Platt & Stephen J. Guynn

Abstract

Improving the state of the art regarding computer based training can be directly linked to the validity and completeness of instructional strategy and the clarity and utility of the terminology and models surrounding the design and development of instructional strategy. Current research emphasis on isolated media variables has not yielded practical results for field practitioners. An alternative holistic approach is to focus on strategy and tactics of computer based training. The **purpose** of this paper is to create a model of strategy and tactics that could lead to a more uniform communications between researchers and developers with categories of strategy that fit the emerging technology. Relevant research issues must be converted into practical guidance of use to designers. Abstract theories must be fortified with working case examples and applications. In a move to operationalize key concepts, four key terms (Interaction, Adaptive, Remediation, and Simulation) were defined in terms of levels of increasing complexity. The proposed model takes into consideration expanded use of artificial intelligence, expert systems, and future use of virtual reality. Learner centered design criteria were identified, with emphasis on interactive formats. The **proposed model** consists of three levels. **General strategy level** consists of a pool of options dealing with the overall training approach. These training approaches can be used in combination to provide a large number of possible general strategies. A sample pool consists of (1) Active Interactive Simulation, (2) Interactive Approximated Simulation, (3) Random Access Discovery Learning, (4) Controlled Path Rehearsal, (5) Scenario Driven Free-play with Active Coaching, (6) Scenario Driven Free-play with Computer Generated Feedback. (7) Opposing Force Game with Active Coaching, (8) Opposing Force Game with Computer Generated Feedback. **Sub strategy (meso tactics) level** deals with the order and use of motivational, evaluative, practice, testing and informational elements. **Working level strategy (basic tactics)** is realized through implementation of a variety of tactics which includes path-option tactics, presentation tactics, learner input or response tactics and feedback tactics. The tactics determine how the audio visual elements will be used as the learner interacts with the program. This is the level that that either makes the overall sequence of events an effective learning experience or a boring, painful and ineffective exercise. A wider selection and mixing of strategy types and tactics along with tighter specification by level of interaction, degree of adaptation, level of remediation, and complexity of simulation; could improve the probability of successful programs. The intended outcome of this model is to provide that opportunity to designers. This will permit Instructional design for CBT to be a flexible exercise, where learning outcomes are more important than rigid formulas for format. The empirical efficacy of various strategies can be established in practice. Training solutions must be evaluated on training effect rather than a tenuous (and often weak) linkage to general theory. Strategy, as used here, should not be confused with theory. Theory must hold over all cases and is therefore general. Strategy bridges the gap from the general to the specific and must only be effective in its intended application. Theory provides guidance and explanation. Strategy leads to accomplishment and the realization of goals and objectives.

Biographical Sketch

William A. Platt received his Ph.D. from Indiana University. He is currently a consultant. Past professional affiliations include Harris Corporation, Loral Corporation and the Naval Training System Center, Orlando Florida. Stephen J. Guynn also received his Ph.D. from Indiana University. He is currently an Evaluation Specialist with the Indiana Prevention Resource Center at Indiana University, Bloomington. Dr. Guynn's past professional affiliations include the Department of the Navy and the Research and Evaluation Department of Indianapolis Public Schools.

A STRATEGY MODEL FOR COMPUTER BASED TRAINING

William A. Platt & Stephen G. Guynn

INTRODUCTION

Instructional innovations have a way of bursting on the scene with high hopes and then fading rapidly into an oblivion of unfulfilled promises, overrun budgets and ambiguous research results. To some extent the history of computer based training or computer based instruction, has followed this course. However, this syndrome is not inevitable. The computer is far too valuable a tool. Computer based training has benefited from a host of second chances. Success stories are mixed in with the disappointments. But the ratio still falls short of the potential. Why has the success rate not been greater? This paper is based upon the proposition that a large part of the answer can be found in three observations on the state of the art. **First,** the language surrounding the art and science of computer based training is full of surplus meaning and is used in differing ways by different practitioners. We have come to depend upon the educational research community for our concepts and terminology dealing with instruction. But instructional research is more often aimed at establishing general principles and conditions. In this endeavor researchers often isolate variables in order to obtain results that will hold up at publication time. Far less research is dedicated to the "praxiology" of instruction where the results are put to use in working settings. That is the domain of strategy and to a great extent it is a neglected domain. **Second,** industry has developed wondrous capabilities to program the computer. In many cases it is the programmer's dream that dominates the basic design and the instructional strategy. Unfortunately most students who use computers are not programmers. This touches on the locus of control issue which has yet to be fully resolved in the realm of CBT. Practical rules for design supported by learning theory or field data, have not kept pace with the programmers capability to invent solutions. **Third,** the available strategy models lack a unifying framework. In some cases models are often closely guarded authoring house secrets. Success in a few areas has limited the selection of strategy to a conservative and narrow path. New workers are "guided" in the company way. This limitation is often compounded by adherence to "templates" which further restricts the creativity and responsiveness applied to program design. Quality control consists of following the pattern rather than measuring the results. These points have recently been supported in the literature on computer based training.

CBT EXPECTATIONS REVISITED

Much of the early hyperbola associated with the tremendous promise of the medium is being set aside in favor of a critical view of the progress made in the last ten to fifteen years. Chen, Brandt, Barbee & Lorenc (1993) point out that CBT is still in its infancy. They recognize that the promise once envisioned for CBT has largely not materialized. Their approach was to focus on improvement by using authoring systems that reduce development time and include the use of a strategy segment library. The use of academic research standards to measure our progress, has turned up some disappointing findings. Terrell (1990) has reviewed the literature on strategies of computer-based instructional design. He was particularly interested in determining the extent that published design guidelines were supported by empirical research. He concluded that very few were supported and that contradictions between guidelines were commonplace as were disagreements between so-called experts. Reeves (1993) casts doubt on much of the learner control research in computer-based instruction. Reeves refers to the research as "pseudo science" which fails to follow the standards of the "quantitative paradigm".

McCombs (1985) investigated Navy and Air Force user acceptance problems with CBT as a function of inadequately prepared instructors and failure to recognize the value of group process roles. A number of other authors have critically examined the theoretical underpinning for aspects of computer training (Milheim & Martin, 1991; Cronin & Cronin, 1992; Rieber & Kini, 1991; Haertel, Walberg, & Weinstein, 1983). Some of our established practices are not supported by empirical research. This of course could partly be because we have been asking the wrong research questions. Rather than teasing out and isolating variables, we should be taking a holistic look at strategy and asking what works and what does not. Rigid academics will undoubtedly continue to follow accepted research designs. Field practitioners on the other hand, face the problem of creating effective instruction and solving training problems under deadlines and cost constraints. Here strategy is useful when it works and discarded when it does not. Both worlds value empirical results but academic research is aimed at establishing grounded theory, while the field practitioner aims at achieving training results. Theory is tested by experimental research, which is linked to the "real" world through operational definitions. To apply theory, some operational variables must be manipulated. In a sense each time a new instructional application is created, a new operational definition is created. In the transition from general rule to specific case, the variation, shading and potential for intervening unknown variables is enormous. Each instance of strategy that claims to follow a principle or a theory must therefore be tested. The role of theory is to generate ideas not to guarantee success. Success is what pilot testing, trial runs, and revising as required are all about. Guidance for practitioners is best expressed as proven strategy rather than general theory.

Emphasis on Strategy. It is time to place emphasis on increasing the inventory of practical strategies that work. Clark (1985) suggests that the training effectiveness of computer based instruction is primarily due to effective instructional strategies and not to the delivery medium. The practitioner uses intuition, hunches, trial and error, and general heuristics, to develop strategy. The point is that these methods often work. When a review of the literature finds that much of current practice is not "supported" by academic theory that does not mean things are not working in the field. In some cases field practice may be ahead of theory. The important thing is to clearly identify what must be learned, and then keep adjusting strategy until the goal is obtained, thus getting back to the original roots of instructional system development. As Kaufman (1992, p 56) points out, we should develop a mindset "that will help us think about how to change what should be changed, keep what works, and modify and develop as required."

CBT STRATEGY ISSUES

What makes up the universe of computer based training / instruction? The "stuff " of CBT consists of instructional issues having to do with learning, delivery issues having to do with the medium, and content issues having to do with analysis and design. Theoretical guidance is evolving (Case & Bereiter, 1984). But the instructional designer must take a stand and use or ignore the guidance currently available. The result is that designer's strategy. This is often invention by default, but never the less it is the designer's attempt to turn ideas into the concrete substance of an instructional program. Designers must consider many things including: Motivation, Reinforcement, Locus of Control, Screen Design, Path Design, Simulation, Motion and Still Frame Video, Animation, Graphics, External Devices, Game Theory, Artificial Intelligence, Pacing, Coaching, Feedback, Team Training, Testing and Evaluation, Remediation and Learning Styles. The point here is that strategy is not a simple thing. Strategy must consider all of this and more and be unambiguously stated. A few commonly used terms have such a range of possibility that they must be pinned down when used in strategy specifications.

TERMS: DEFINITION BY LEVEL

Instructional designers and contracting *officers should take note of four terms* commonly used for developing CBT strategy. These words are "interactive, adaptive, remediation and simulation." The range of meaning of these terms as they are being applied to computer based instruction is too great to permit them to be used with out accompanying operational definition. *The following four tables are intended to* show some of the range of meaning possible.

Table 1. Levels of Interaction

Level 1	**Learner is exposed to material and advances by manual or automatic "next" switch which is not contingent upon comprehension of material.**
Level 2	**Learner is exposed to material that requires a decision or discrimination which must be completed. Advancing to the next part is contingent upon a response relative to the content.**
Level 3	**Learner is exposed to material that requires a decision or discrimination and discrete control input, constructed external response, tool use, or continuos control input.**
Level 4	**Learner is exposed to material that presents a problem requiring learner to formulate questions, hypothesis, game moves, or dialogue with artificial intelligence, or active player or coach.**

Table 2. Adaptive Levels

Level 1	**Learner can elect to adjust pacing or other minor control parameters or program makes pacing adjustments based upon response time.**
Level 2	**Learner can elect to adjust pacing or other minor control parameters or program makes pacing adjustments based upon response time and program includes additional Artificial Intelligence / Expert Systems diagnostics which adjust content, level of detail, and explanation step size.**
Level 3	**All above plus learner can elect various tracks which accommodate leaning style and program includes a range of voluntary or automatic Artificial Intelligence / Expert Systems diagnostics and helps. For example a discovery learning track in addition to traditional program.**

Table 3. Levels of Remediation

Level 1	**Learner fails test or check question and is routed back to earlier point in the same program**
Level 2	**Learner fails test or check question and is provided alternative material that is different from original program either in content, detail, step size, or pacing. Learner re-enters program at point of original failure.**
Level 3	**Learner fails test or check question and is provided diagnostic and then additional material based upon the results and then additional practice before being returned to original point. Artificial Intelligence / Expert Systems used to monitor student may intervene before student make errors to provide additional explanation.**

Table 4. Levels of Simulation (Fidelity, Timing, and Options)

Level 1	**Entity is modeled in part with limited fidelity and not in real time.**
Level 2	**Entity is modeled in multiple functional aspects at moderate fidelity close to real time and limited to visual and audio cues.**
Level 3	**Entity is modeled in full functional aspects in high fidelity in real time with full free play possible , may use virtual reality, and full range of environmental cues.**

A STRATEGY MODEL

The model proposed below takes advantage of the technological options opened up by advances in computer science. The model has three levels, each level focusing on a different aspect of the computer based delivery of instruction.

General Strategy Level. General strategy is the overall specification for action aimed at accomplishing specific goals and objectives. Top level strategy is a statement of the general approach which specifies main feature of the strategy and the active factors in the program. This includes the human participants, the machine capabilities, and the conceptual models that guide the program structure. The number of specific strategies is great, but it is possible to group strategies by salient feature. This creates a pool of base types.

Sub-Strategy (meso tactics) Level. This relates to the use of motivational, informational, evaluative, practice, feedback and testing elements, each containing one or more instructional maneuvers that support the general approach. While the general strategy level indicates the Who, What, When, and Where, of strategy. The sub-strategy covers the all important Why issues. It is where the content meat, the motivational purpose, and the presentation and response interactions are specified. When the elements are added up they deliver a fully functional instructional program.

Working Level Strategy (basic tactics) Level. This level deals with the "How" issue. Each element which serves a purpose related to final goal achievement, must be executed through some tangible means or mechanism. Instructional moves are operatonalized and implemented through tactical employment of various mechanisms for learner interaction with the program. Basic tactics are what the learner experiences when using the program.

Table 5. A Three Level Model Of Strategy and Tactics

The General Strategy Level	**Salient Feature, Participants, Resources**
The Sub-Strategy (meso tactics) Level	**Instructional Moves and Program Parameters, Elements Included,**
The Working (basic tactics) Level	**Mechanics of Elements, Screen Design, Element Path and Linkage,**

EIGHT GENERAL STRATEGY TYPES

Active Interactive Simulation. The key feature of this strategy involves a simulation of an entity which supplies data to the learner who is able to perform various task operations in any order and receive feed back that reflects operation of the system *being modeled.* For example a flight simulator or ship simulator can be operated by the learner who can provide control inputs see instrument displays as well as out the window display.

Interactive Approximated Simulation. The key feature of this strategy is that a partial simulation of an entity is use to provide interaction in a sub-set of the system. A panel trainer for example provides correct indications for selected trouble-shooting routines but does not model the *entire operation of the system.* The learner will only get meaningful system interaction with in the target sub-system.

Database Access Discovery Learning. This strategy involves a relational data base containing some domain of knowledge. The learner is able to query the data base and interact with short learning segments on a random *basis.* The strategy depends on the learner gradually realizing patterns and relationships with in the data and integrating the data into a learner designed frame-work. Learners may use this strategy in connection to a challenge task that depends upon the data in the data base.

Controlled Path Rehearsal. This strategy is often used in procedure based equipment operation or complex serial tasks like weapons system operation/ deployment or maintenance trouble shooting. The learner steps through the task *following prompts* that are gradually removed until a practice session is completed free of prompts.

Scenario Driven Free-play with Active Instructor Coaching. When the task involves mission level activities and group behavior that is performed in a team setting, a simulation of the situation may be coupled with an event driven scenario that presents opportunity to practice task interactions under various contingencies which may involve emergencies, unexpected attacks, system failures, or just routine operations under various degrees of stress. Players are free to make moves as they chose in relation to events. Coaches provide feedback, and advice at their discretion. A variation of this strategy can include on line helps and play back elements that can be inserted at the discretion of the coach.

Scenario Driven Free-play with Computer Generated Feedback. This is similar to the above strategy except that the computer is programmed to provide error messages, and other types of feedback in response to certain moves or omissions on the part of the student.

Opposing Force Game with Active Instructor Coaching. This strategy uses game rules tied to the performance of leaning tasks. Learner moves are countered by the coach who may counter learner movers to illustrate some aspect of the task being learned. This strategy is often used to teach students the dynamics of market forces in a competitive environment, or principles of war and weapons employment in military applications. Students may play against each other, against the coach, or against the computer.

Opposing Force Game with Computer Generated Feedback. This is similar to the strategy above except that the computer is programmed to respond to certain situations to counter student moves or provide feedback and advice.

SUB-STRATEGY ELEMENTS

Motivational Elements. A motivational element is a section of a strategy that is intended to motivate the student to learn the material in the lesson. As such the motivational element must be motivating given the learner and the learning task. An example of a motivational element would be a sequence that describes the importance of the task and shows the consequences of failure. Another motivational element would be a sequence that uses a scoring system based upon performance. The element explains that points can be earned toward obtaining a password that would access a higher level skill version of the program. Points would then be awarded as the student performs in the rest of the program.

Evaluative Elements. Evaluative elements are placed in a program to provide feedback on student performance relative to a standard. This form of feedback may be delivered by computer or a live instructor/coach.

Practice Elements. Practice elements are sequences where the student gets to apply what has just been leaned in an earlier part of the program. The elements may strengthen and widen the learned response being practiced by offering the opportunity to apply the skill or knowledge to a wider set of conditions than the original sequence. Practice elements may be used to test "transfer" to increasingly realistic or difficult situations. Practice elements are usually linked to testing elements or may contain monitoring elements.

Testing Elements. Testing elements check performance. They may be used with information elements or as tests for the record. Testing elements are most often the points of departure for tactical control of the student in the program. Several path options are discussed under tactics. Test elements can be "on-line" or "off-line" as required by the content and nature of the test.

Informational Elements. The content of instruction is delivered in these elements through text, graphics including animation and video and audio voice and tone. In the newer programs that use a "hyper" media format informational elements can also become points of departure to move to other elements using buttons and windows. Informational elements and test elements may be combined into a single frame. It is highly desirable that all advances from informational element to informational element be contingent upon learner comprehension evidenced by a test (see testing element).

On-call and Background Elements. The Monitoring and Pause options are elements that can be called upon at any point in a program. Background elements are used in simulations and other strategies that require background calculations.

TACTICS WITHIN ELEMENTS

Path Option Tactics:

(a) Contingent Moves. The student is required to perform some input action in order to move to another segment of the program. The input may be the answer to a question or recognition of an object etc. but should be meaningful in terms of the content and learning required in the program.

(b) Hyper moves. The student can elect to gain more information about a term or object by selecting it using an input device. The information will be conveyed in a window. The student returns to the program when ready.

(c) Traditional path types. Traditional path types include the **true branch** leads the student to a different concluding point in a sequence. The **side track** leads the student to a common concluding point in a sequence (also called alternate path route). The **return jump** which jumps the student to an earlier point in the program. The **remedial loop** provides additional steps with new material and then returns the student to the point where the loop was joined. The **escape jump** takes the student to a menu or out of an entire sequence. Path types can be used in combination to form larger sets in elements to achieve the element objective.

Presentation tactics: Presentation tactics are the ways that sound, text, graphics animation and video are used to convey information or to elicit a response from the learner. This is one area where creativity and imagination can make the difference between a dull lifeless and boring program and a motivating and effective learning experience.

Learner Input Tactics: Input tactics are the ways that learners can respond to the program. Responses can be discrete selections of point and click answers, constructed keyboard input which is a series of discrete key strokes, or continuos movement as when control inputs are made by using a joystick. Learners may also use test leads to hook up a circuit. Mechanisms like "drag and drop", made available by object oriented programs, have provided some clever possibilities to designers.

Feedback Tactics: Feedback tactics are the ways that sound, (tones and voice), text, graphics, animation, and video are used to confirm, guide, advise, or prompt the student following a student input. Instructor intervention is also used to motivate, correct, adjust, and guide the students performance.

SAMPLE STRATEGY SPECIFICATION

Sample General Strategy: Scenario Driven Free-play with Active Coaching, Training situation: Student Pilot leaning to fly instrument approach following approach plate and air control instructions. Objective: To make the correct control inputs and turn aircraft at the correct points to fly the approach based upon verbal instructions, approach plate and instrument readings. Equipment and software: Computer with interactive level three, remediation level three, adaptive level two programming, level two simulation and mouse and joy stick input devices. The program is free play in that the student can turn the aircraft in any direction not just the correct direction. The program simulates an instrument display and is classified level two because the database and math model are limited instrument readings relative to plane heading and aircraft attitude. The scenario includes the events of the approach in sequence and inputs from an instructor coach who plays the controller.

Sample-Sub-Strategy; Start. Element-1 Motivational, Element 2 orienting instruction, Element 3 cockpit display, Element 4 Explain Control Tower Request, Element 5, Explain come to heading, Element 6, Explain arc intercept, Element 7 Explain turn to final, Element 8 Explain altitude decision On call element error detection alert, On call element program pause/ instructor critique, Background element math model for approach scenario, On-Call element evaluation checks and tests, Student activates scenario by completing tests for elements one to eight. Event control triggered by scenario real time triggers and by aircraft position in the approach. Instructor coach provides feedback as needed.

Basic Tactics: Tactics are required for each element of strategy. Only a few elements from the above example will be shown here due to lack of space. The examples are provided to make the point that the "how to do it" level requires detailed description. Tactics for Element 1(motivational), Fade in- Video sequence of aircraft safely landing Voice comment that *the pilot had just completed an instrument* approach, Video sequence showing consequences of task failure, Voice comment reminding pilot of the importance of instruments in bad weather. Upon completion of sequence program moves to element 2. Tactics for Element 2 (information) animation of air craft moving through the approach in three dimensional diagram with each stage identified by a pop-up window. Student must answer question to move to element three. Questions are implemented with "drag and drop". Tactics for element 3 (information), Graphic of instruments with highlight of the ones involved, Task statement boxed with objective for lesson. Each of the terms and instruments in element 2 can be used to access a help screen with amplifying information . The student input device for element 2 & 3 is a mouse. Instrument dials are moving according to the heading of a *small aircraft model that the student* manipulates to trace the approach plate. (These sample tactics statements are only a partial listing for this strategy).

CONCLUSIONS

Improved Specifications. The use of a standard model for stating strategy, and the existence of a data bank of proven strategies, would be of great benefit to instructional developers and to CBT contractors. Statements of work for CBT contracts could include a specification of strategy. Cost estimates can be improved when the complexity of the program is defined using a strategy specification. The nature of CBT is changing. Once the bedrock of a program, the concept of a frame, for example, is no longer straight forward. The simple linking of frames in a path breaks down with the introduction of windows and "hypermedia" formats (Marchionini, 1988; Morariu, 1988). The use of "templates" will require care to avoid uncreative over use of easy fast solutions at the expense of meaningful motivating programs.

Domain Specific. As specific strategies are tested through use in the field, some strategies will tend to be narrow covering only a single target objective. Others may work for a wide range of objectives. Some instructional design texts stress the "domain" independence of strategy. Chen et al. (1993) defines domain as "the combined knowledge and skills in a specific topic area. " From our point of view having a strategy work for more than one domain is desirable, but should not be a design goal for strategy. We encourage creative use of strategy in all domains to see what works and what does not. A failure to try out new ideas is one reason why there are so many examples of dull programs in today's instructional inventory.

Pilot Testing. Greater emphasis on pilot testing and revision of programs and their strategies will ensure that programs are effective. This will also provide researchers with grist for their mills trying to find out why programs work even when no theory can be found to explain the results.

Share Information. Field practitioners must start to share information and results and reach a common usage of terms relating to strategy and tactics. The nature of the exchange between instructional designers and educational researchers also needs to change. Researchers rarely get to ask the question : "why does this strategy work?" As strategy is refined and successful strategy noted, researchers will get that chance.. An inventory of proven strategy ideas can be placed in a data based for both field workers and researchers.

A Starting Place. This model is a starting place and should be adjusted each time an innovative new CBT program achieves desirable results. The industry has only begun to explore the possible strategy and tactics combinations. The potential rewards as well as the inevitable frustrations will be even greater as new technology emerges especially artificial intelligence and virtual reality. Will educators and trainers learn from the game designers and entertainment community? Will CBT designers become more creative and adaptive to change? Will clients demand training that is not only informative and accurate but exciting and not-boring? We think yes answers to all three questions are both inevitable and desirable.

REFERENCES

Case, R. & Bereiter, C. (1984). From Behaviorism to Cognitive Behaviorism, to Cognitive Development: Steps in the Evolution of Instructional Design. Instructional Science, 13, 141-158.

Chen, T. T. , Brandt, L. M. , Barbee, D. E., & Lorenc, D. R. (1993). The Global Guide to the World of CBT Authoring. Champaign: Global Information Systems Technology, Inc.

Clariana, R. B. (1993). A Review of Multiple-Try Feedback in Traditional and Computer-Based Instruction. Journal of Computer-Based Instruction, 20, (3), 67-74.

Clark, R. E. (1985). Evidence for confounding in computer-based instruction studies: Analyzing the meta-analyses. Educational Communication and Technology Journal, 33, 249-262.

Cronin, M. & Cronin, K. (1992) A Critical Analysis of the Theoretic Foundations of Interactive Video Instruction. Journal of Computer-Based Instruction, 19, (2), 37-41.

Haertel, G., Walberg, H., & Weinstein, T (1983). Psychological Models of Educational Performance: A Theoretical Synthesis of Constructs. Review of Educational Research, 53, (1), 75-91.

Kaufman, R. (1992). Strategic Planning Plus: An Organizational Guide. Newbury Park: Sage.

Marchionini, G. (1988). Hypermedia and Learning: Freedom and Chaos. Educational Technology, November , 8-12.

McCombs, B. L. (1985). Instructor and Group Process Roles in Computer-Based Training. ECTJ, Fall, 159-168.

Milheim, W. D. & Martin, B. L. (1991). Theoretical Bases for the Use of Learner Control: Three Different Perspectives. Journal of Computer-Based Instruction, 18, (3), 99-105.

Morariu, J. (1988). Hypermedia in Instruction and Training: The Power and the Promise. Educational Technology, Nov. 17-20.

Reeves, T. C. (1993). Pseudoscience in Computer-Based Instruction: The Case of Learner Control Research. Journal of Computer-Based Instruction, 20 (2), 39-46.

Rieber, L. & Kini, A. (1991). Theoretical Foundations of Instructional Applications of Computer-Generated Animated Visuals. Journal of Computer-Based Instruction, 18, (3), 83-88.

Santiago, R. S. & Okey, J. R. (1992). The Effects of Advisement and Locus of Control on Achievement in Learner-Controlled Instruction. Journal of Computer-Based Instruction, 19, (2), 47-53

Terrell, D. J. (1990). Strategies of Computer-Based Instructional Design: A Review of Guidelines and Empirical Research. Technical Report 888 United States Army Research Institute for the Behavioral and Social Sciences: Alexandria, Virginia.