CHAPTER 3

WHAT WORKS IN DISTANCE LEARNING: INSTRUCTIONAL STRATEGIES

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The following guidelines are presented in this chapter:

Strategies Based on Providing Learner Control of Instructional Navigation

Strategies Based on Providing Worked Examples and Practice

Strategies Based on Effective Feedback During Learning

Strategies Based on Teaching Concepts

Strategies Based on Teaching Process Knowledge

Strategies Based on Teaching Causal Principles

Strategies Based on Teaching Procedural (How to) Knowledge

Strategies Based on Providing Learner Control of Instructional Navigation

(Clark, v.7, 1/8/04)

1. Guideline:	As the extent of learner control increases, learning decreases except for the most advanced expert learners.
2. Guideline based on:	Research
3. Degree of confidence:	High
4. Comments:	The high levels of learner control afforded by distance learning media and contexts are often described as one of the potential advantages of distance learning (Hannafin & Sullivan, 1995). Yet the evidence from a great variety of studies examining different learners, learning tasks, and settings suggests that as the extent of learner control over various aspects of instruction increases, learning may decrease. This seems to be the case even when learners are assigned to their preferred level of control over instructional presentations (Niemiec, Sikorski, & Walberg, 1996). While it is possible to find studies that provide evidence for the benefits of some limited forms of learner control, such as control over the pacing of a presentation (Doherty, 1998), it is likely that more extensive control aids only the learning of students with very high levels of prior knowledge of the subject matter and/or those who have learned how to benefit from increased control. A comprehensive review and meta-analysis of many learner control studies by Niemiec et al. (1996) reported an overall negative impact. This negative impact extends to studies

where learners were allowed to select the amount of control they exercised over their course (Hannifin & Sullivan, 1995). While system control of instructional events and strategies may not be helpful to more advanced students, it apparently does not harm them (Hannifin & Sullivan, 1995). Thus it does not appear to be harmful to provide system control of instruction to even more advanced learners.

5. References:

Doherty, P. D. (1998). Learner control in asynchronous learning environments. *ALN Magazine, 2*(2). Retrieved December 4, 2002, from http://www.aln.org/alnweb/magazine/vol2_issue2/doherty.htm#1-7

Hannafin, R. D., & Sullivan, H. D. (1995). Learner control in full and lean CAI programs. *Educational Technology Research and Development, 43*(3), 19-30.

Niemiec, R. P., Sikorski, C., & Walberg, H. J. (1996). Learner-control effects: A review of reviews and a meta-analysis. *Journal of Educational Computing Research, 15,* 157-174.

6. Glossary:

Contingencies: Decision rules that guide instructional presentations based on learner performance within a course. So, for example, if a learner enters a wrong answer for a practice test item, a system contingency might be to direct the student to review relevant sections of the lesson and then repeat the practice.

	Instructional strategies: Methods of organizing, sequencing, and presenting instruction that increase both student learning and the transfer of their learning to application contexts. Instructional strategies or methods are external representations of internal cognitive processes that are required to learn but which learners will not or cannot provide for themselves efficiently or effectively.
	Learner control: The degree to which instruction permits individual students to control the path, pace, and/or contingencies of instruction.
	Learning strategies: The techniques or methods students use to learn or acquire new information. Learning strategies are methods used by learners to learn; instructional strategies are methods that the instructional program provides to support learning.
	Pacing: The speed with which a course presents information to students.
	Sequencing: The order in which information, lessons, and learning tasks are presented to students within a course.
7. User:	Instructional designer and developer

Strategies Based on Providing Worked Examples and Practice

(Clark, v.7, 1/8/04)

1. Guideline:	When instruction provides clear and complete procedural "worked" examples of the decisions and actions needed to solve problems and perform necessary tasks to be learned, then learning and transfer to work performance will be increased.
2. Guidelines based on:	Research
3. Degree of confidence:	High
4. Comments:	Experiments comparing worked examples with conceptual instruction and problem-based discovery learning (Kalyuga, Chandler, Touvinen, & Sweller, 2001; Touvinen & Sweller, 1999) found clear evidence that worked examples were superior and enhanced not only learning but transfer of learning outside of the training setting. Touvinen and Sweller (1999) and Kalyuga et al., (2001) also found that the benefit of worked examples decreased and the benefit of problem solving increased as learners became more expert. van Merrienböer (1997) strongly suggested that the use of worked examples to solve task-relevant problems should be an essential component of all practice during instruction (with accompanying conceptual explanations of why different elements of the procedure "work" to achieve a performance goal). These worked examples should also result from a cognitive task analysis. Touvinen and Sweller (1999) demonstrated that when properly designed, worked examples are superior to

discovery learning for all but the most advanced learners, and that even advanced experts get equal benefit from discovery learning and worked examples and so seem not to be harmed by examples. However, Kalyuga et al. (2001) found that experts benefited more from solving problems than from worked examples. van Merrienböer, Clark, and de Croock (2002) provided an example of a worked example for teaching Web-based information search.

5. References:

Kalyuga, S., Chandler, P., Touvinen, J., & Sweller, J. (2001). When problem solving is superior to worked examples. *Journal of Educational Psychology, 93,* 579-588.

Touvinen, J. E., & Sweller, J. (1999). A comparison of cognitive load associated with discovery learning and worked examples. *Journal of Educational Psychology, 91,* 334-341.

van Merrienböer, J. J. G. (1997). *Training complex cognitive skills. A four-component instructional design model for technical training.* Englewood Cliffs, NJ: Educational Technology Publications.

van Merrienböer, J. J. G., Clark, R. E., & de Croock, B. M. (2002). Blueprints for complex learning: The 4C/ID-model. *Educational Technology Research and Development*, *50*(2), 39-64.

6. Glossary:

Cognitive task analysis: A method of analyzing decision and analytical procedures in which an interviewer collects from experts a temporal order of overt actions and mental (covert) decisions (solutions) required to achieve a goal state from a given state (problem or current conditions).

Given state: The description of an existing problem or current “condition” that must be changed in order to achieve a “goal state” or objective.

Goal state: The desired end-result or objective of the performance being learned.

Procedure: A sequenced list of overt actions and covert decisions (with the criteria or rules for selecting alternatives as decisions are being made) that enables the learner to transform a given state to a goal state.

7. User: Instructional designer

Strategies Based on Effective Feedback During Learning

(Clark, v.7, 1/8/04)

1. Guideline:	The more that learning and performance feedback (a) is based on concrete learning goals that are clearly understood by students, (b) describes the gap between the student's learning goal and the student's current performance and suggests how to close that gap, and (c) focuses the student's attention on the learning goal and not on his/her failure to achieve the goal, the more effective it becomes for learners, learning, and transfer of learning to performance settings.
2. Guideline based on:	Research
3. Degree of confidence:	High
4. Comments:	Feedback during learning has been examined for many years by many different researchers with very mixed and often conflicting results (Kluger & DiNisi, 1998). Recent attempts to resolve these disagreements have begun to pay off. For example, a recent international review of well-designed performance feedback research studies (Kluger & DiNisi, 1998) produced a surprising insight. Performance feedback actually depressed performance in one third of all feedback research studies conducted both in natural settings and in the laboratory. In another third of the studies, performance feedback had no impact. In only one third of the studies did feedback increase performance. It appears that effective performance feedback must be focused on building the learner's self-efficacy for the

learning task and closing the gap between learning and/or performance goals and the individual’s current progress. Feedback is effective only when learning goals are clearly understood. When feedback points out poor performance or a lack of performance, or when it suggests that the performer is “wrong” or is being made responsible for goals that were not made clear initially, performance most often deteriorates. This finding by Kluger and DiNisi (1998) reflects a similar conclusion reached as a result of two very solid but independent research programs directed by Bandura and Locke (2003), who argued that “discrepancy” feedback often damages both learning and performance. They explained that making a person responsible for mistakes not only restricts current learning but often damages future learning by impacting self-efficacy. Kluger and DiNisi (1998) also emphasized that when adults feel that their learning will be directly transferable to their work and when their work performance is connected to their personal growth, performance feedback is most beneficial. The finding that poor feedback was obvious in two thirds of all the research studies in Kluger and DiNisi’s review suggests that it may be even more prevalent in practice since researchers tend to select what are thought to be the best strategies to test in experiments. Thus the best feedback appears to involve complimentary comments about what was done well and a dialogue about strategies for achieving goals that are not yet attained.

It is doubtful that any feedback strategy will work equally well for all learners or that a strategy that conforms to the suggestions made by Kluger and DiNisi (1998) will succeed for everyone. There is some evidence, for example, that learners who are motivated to "look good" but who do not value learning what is being taught will not benefit from learning results or strategy feedback, and there is also evidence that when learning tasks are easy to achieve, pointing out mistakes and attributing them to the learner may be helpful (Wofford & Goodwin, 1990).

5. References:

Bandura, A., & Locke, E. A. (2003). Negative self-efficacy and goal effects revisited. *Journal of Applied Psychology, 88,* 87-99.

Kluger, A., & DiNisi, A. (1998). Feedback interventions: Toward the understanding of a double-edged sword. *Current Directions in Psychological Science, 7*(3), 67-72.

Wofford, J. C., & Goodwin, V. L. (1990). Effects of feedback on cognitive processing and choice of decision style. *Journal of Applied Psychology, 75,* 603-612.

6. Glossary: *Discrepancy feedback:* A negative feedback control system aimed at error correction (Bandura & Locke, 2003, p. 87).

7. User: Instructional designer

Strategies Based on Teaching Concepts

(Clark, v.7, 1/8/04)

1. Guideline:	If new concepts are taught by providing a definition of the concept, examples from the work environment, and practice exercises in which learners are asked to correctly classify many different work-relevant concept examples, then learning will be enhanced.
2. Guidelines based on:	Research
3. Degree of confidence:	High
4. Comments:	Concepts are any unit of knowledge that has a definition and at least one example. Learners often must learn a great variety of concepts to support accurate classification of events and objects in their work environment. When designing instruction for concepts, it is vital to begin by developing an accurate definition that contains a complete list of only the defining attributes or features of the concept. In addition, instruction must provide work-related examples and practice exercises in which learners are asked to classify a number of new examples of the concepts being learned. This type of instruction results in learning that should transfer to work environments or out of the classroom to everyday life (Howard, 2000). If transfer is required to very novel applications beyond the current work environment (far transfer), then in addition to practice classifying work-related examples, instructional designers should also include a variety of novel examples of each concept. The more that learners practice classifying

varied and novel examples, the higher the probability that they will be able classify very novel new examples in a variety of contexts (Howard, 2000).

5. References:

Howard, R. W. (2000). Generalization and transfer: An interrelation of paradigms and a taxonomy of knowledge extension processes. *Review of General Psychology, 4,* 211-237.

Merrill, M. D. (1983). Component display theory. In C. M. Reigeluth (Ed.), *Instructional design theories and models: An overview of their current status* (pp. 279-333). Hillsdale, NJ: Erlbaum.

Merrill, M. D., & Tennyson, R. D. (1977). *Teaching concepts: An instructional design guide*. Englewood Cliffs, NJ: Educational Technology Publications.

6. Glossary:

Concepts: Any unit of knowledge that has a definition and at least one example.

Far transfer: Knowledge is generalized from the context and examples where it was originally learned and is applied to contexts and examples that are extraordinarily different from the original learning context.

Near transfer: Knowledge is generalized from the context and examples where it was originally learned and is applied to contexts and examples that exist in a work environment that is similar to the one emphasized during learning.

7. User: Instructional designer

Strategies Based on Teaching Process Knowledge

(Clark, v.7, 1/8/04)

1. Guideline:	When designing instruction for a process (how something works), give students a clear narrative description integrated with a visual model of the sequence of events that characterize the process, and describe each stage in the process and what key events or actions occur at each stage to produce a change that leads to the next stage.
2. Guidelines based on:	Research
3. Degree of confidence:	Medium
4. Comments:	Learning about processes (how something works) requires that a student be able to accurately describe each stage in the process, the actions that occur at each stage, and how the consequences of each action lead to the next stage. Designers sometimes confuse processes with procedures (how someone does something). Processes are often called “mental models” in instructional research. Visual models of a process are often accompanied by a fully integrated narrative of events that occur at each stage and how they lead to the next stage to help students remember both the sequence of stages and the events that occur at each stage. Process knowledge helps learners develop a mental model of an important series of related events in a work setting. Processes can, for example, describe human activities (how a team functions, or should function, to achieve a task), biological events (photosynthesis), or mechanical systems (how the expended shell rejection mechanism works on a

weapon). It is important to remember that learning about a process will not ensure that learners will be able to use the process to, for example, make accurate predictions or engage in troubleshooting. Both prediction (what if . . .) and troubleshooting (here is a problem with the system . . . fix it) require procedural knowledge, worked examples, and a great deal of practice (learn by doing).

5. References:

Carroll, J., & Olson, J. (1988). Mental models in human-computer interaction. In M. Helander (Ed.), *Handbook of human-computer interaction* (pp. 45-65). Amsterdam: North-Holland.

Markman, A., & Gentner, D. (2000). Thinking. *Annual Review of Psychology, 52,* 223-247.

Merrill, M. D. (1983). Component display theory. In C. M. Reigeluth (Ed.), *Instructional design theories and models: An overview of their current status* (pp. 279-333). Hillsdale, NJ: Erlbaum.

Merrill, M. D. (2000). Knowledge objects and mental models. In D. Wiley (Ed.), *The instructional use of learning objects.* Bloomington, IN: AIT/AECT. Retrieved October 17, 2002, from http://www.reusability.org/read/chapters/merrill.doc

6. Glossary:

Mental model: "A representation (in our mind) of a physical or biological or social system, with a plausible cascade of causal associations connecting the input to the output. In other words, the mental model is a mental

	structure that reflects the user's understanding of a system" (Carroll & Olson, 1988, p. ___).
	Process knowledge: Knowledge about how something works. "It answers the question, 'What happens?' " (Merrill, 2000, p. 12).
	Worked example: A description of "how to," providing clear, step-by-step descriptions of all actions and decisions necessary to achieve a performance goal in the context of a demonstration of an application to a typical problem in a setting that mirrors the application environment where the procedure will be used.
7. User:	Instructional designer

Strategies Based on Teaching Causal Principles

(Clark, v.7, 1/8/04)

1. Guideline:	When teaching causal principles, the more the learner is provided (a) a statement about the cause and resulting effects, (b) a worked example drawn from the application setting, (c) practice that encourages the elaboration of the elements and sequence of the causal chain and then application of the principle to solve a problem that requires a prediction, and (d) practice in the application of the principle to gradually more novel and complex examples, the more effective will be the learning and transfer to the job.
2. Guidelines based on:	Research
3. Degree of confidence:	Medium
4. Comments:	Effective training often requires that learners understand the conceptual or scientific basis for work processes and procedures. Causal principles reflect the content of some of the most complex knowledge background for technical procedures. Reigeluth (1999) described the many different instructional strategies that have been found to help learners acquire knowledge about causal principles. He suggested first defining the cause-effect relationship (a generality) and then providing a typical worked example. To achieve maximum learner participation, Reigeluth suggested providing opportunities to explore a dynamic example. For instance, in a distance, computer-based lesson on the principles that influence the behavior of light on

different types of lenses, the learner might be invited to click on tabs that change the thickness or shape of a lens (cause) and see the path, focal distance, and magnification of the image (effects) change correspondingly.

During instruction, it seems more effective to focus the learner's attention on important elements of the principle and suggest shorthand ways to describe it. Examples and practice exercises should begin with simple worked examples and then gradually present more complex, novel, and difficult examples in which learners are asked first to describe and label each phase of the cause-and-effect chain in the correct order, and then, when given one phase, to predict the next phase or the previous phase, and then to use the principle to solve increasingly novel problems.

5. References:

Merrill, M. D. (1983). Component display theory. In C. M. Reigeluth (Ed.), *Instructional design theories and models: An overview of their current status* (pp. 279-333). Hillsdale, NJ: Erlbaum.

Newton, D. E. (1996). Causal situations in science: A model for supporting understanding. *Learning and Instruction, 6*, 201-217.

Reigeluth, C. M. (1999). *Instructional-design theories and models: Volume II.* Mahwah, NJ: Erlbaum. [Chapter on teaching principles.] Summarized and retrieved December 4, 2002, from http://www.indiana.edu/~idtheory/methods/module_5_4.html

6. Glossary:	*Worked example:* A description of "how to," providing clear, step-by-step descriptions of all actions and decisions necessary to achieve a performance goal in the context of a demonstration of an application to a typical problem in a setting that mirrors the application environment where the procedure will be used.
7. User:	Instructional designer

Strategies Based on Teaching Procedural ("How to") Knowledge

(Clark, v.7, 1/8/04)

1. Guideline:	Effective instruction about "how to" procedures should provide (a) clear, step-by-step "how to" descriptions of all actions and decisions necessary to achieve a performance goal, (b) demonstration of the procedure with a model and/or worked example, (c) conceptual knowledge in the form of concepts, processes, and principles that explain why the procedure works, and (d) the opportunity to practice the procedure on problems and in settings that mirror the application environment where the procedure will be used.
2. Guidelines based on:	Research
3. Degree of confidence:	High
4. Comments:	"The ultimate aim of training is procedural learning, that is, for trainees to be competent in performing a job" (Druckman & Bjork, 1994, p. 147). Thus learners must be able to translate all instruction into step-by-step actions and decisions, transfer them from training, and apply them appropriately on the job to achieve performance goals. Instructional strategies for teaching procedures require the development of an accurate and clearly described sequence of necessary actions and decisions. Procedures that are derived from expert-based cognitive task analysis (van Merrienböer, Clark, & de Croock, 2002) are preferable. When teaching procedures, the more that instruction is based on expert-based descriptions of the sequence of

actions and decisions necessary for goal achievement, and is accompanied by one or more worked examples and the opportunity for part-whole practice that reflects the learner's prior knowledge, and is accompanied by a conceptual elaboration of the declarative knowledge base supporting the procedure, the more effective will be the learning and transfer of the procedure back to the job environment.

Elaborate expert procedures should be chunked into segments of seven to nine new (to the learner) steps (to avoid cognitive overload) during instruction and accompanied by worked examples and conceptual explanations of their underlying principles, processes, and concepts. Where possible, practice of team-based procedures should occur in cooperative groups. When practicing, learners should be asked to explain orally or in writing how a solution was achieved. Practice of parts of a procedure must be followed by "whole task" practice where procedural chunks are gradually assembled into larger "wholes," and feedback should focus on closing the gap between current and required performance (Druckman & Bjork, 1994, pp. 25-56).

5. References:

Clark, R. E. (1999). Yin and Yang cognitive motivational processes operating in multimedia learning environments. In J. J. G. van Merrienböer (Ed.), *Cognition and multimedia design* (pp. 73-107). Herleen, Netherlands: Open University Press.

Druckman, D., & Bjork, R. A. (1994). *Learning, remembering, believing: Enhancing human performance*. Washington, DC: National Academy Press.

Merrill, M. D. (1983). Component display theory. In C. M. Reigeluth (Ed.), *Instructional design theories and models: An overview of their current status* (pp. 279-333). Hillsdale, NJ: Erlbaum.

van Merrienböer, J. J. G., Clark, R. E., & de Croock, B. M. (2002). Blueprints for complex learning: The 4C/ID-model. *Educational Technology Research and Development*, *50*(2), 39-64.

6. Glossary:

Cognitive overload: A condition where the amount of declarative information that a learner is attempting to hold in working memory (consciousness) in order to learn or solve problems exceeds its capacity (estimated to be 4 +/- 1 chunk of declarative knowledge). Overload is hypothesized to result in a shifting of attention away from learning goals (Clark, 1999).

Worked example: A description of "how to," providing clear, step-by-step descriptions of all actions and decisions necessary to achieve a performance goal in the context of a demonstration of an application to a typical problem in a setting that mirrors the application environment where the procedure will be used.

7. User: Instructional designer