Running head: First Principles of Instruction

First Principles of Instruction: A synthesis

* Merrill, M. D. (2007). First principles of instruction: a synthesis. *Trends and Issues in Instructional Design and Technology, 2nd Edition.* R. A. Reiser and J. V. Dempsey. Upper Saddle River, NJ, Merrill/Prentice Hall. **2:** 62-71.

M David Merrill

Emeritus Professor, Utah State University

Visiting Professor, Florida State University

Abstract

A set of interrelated principles for instructional design are identified and listed as questions to ask about an instructional product. Following each question are instructional principles that have been identified and stated by other authors. These principles support and in some cases elaborate the principles that have been identified. Each of the principles included in this synthesis has been supported by empirical research which is described in the source from which the principle has been quoted. It is believed that there is a direct correlation between the effectiveness of an instructional product and the degree to which the product implements these first principles of instruction.

First Principles of Instruction: A synthesis

Recent years have seen a proliferation of instructional design theories and models. Instructional design theory varies from basic descriptive laws about learning to broad curriculum programs that concentrate on what is taught rather than on how to teach. Are all of these design theories and models merely alternative ways to approach design? Do all of these design theories and models have equal value? Do these design theories and models have fundamental underlying principles in common? If so what are these underlying first principles? Previously (Merrill, 2002a) I outlined a set of first principles for instructional design derived from a study of a number of different instructional design theories and models. It was concluded that these different theories and models do share common principles and that they do not incorporate fundamentally different principles. No theory or model previously reviewed includes principles that are contrary to those identified.

The identification of first principles does more than merely collect a set of prescriptive principles that might be used to select or design effective instruction. These principles are interrelated to one another. A four phase cycle of instruction was identified (see Figure 1) consisting of activation, demonstration, application, and integration. Effective instruction involves all four of these activities repeated as required for different problems or whole tasks.

Learning is facilitated when the first activity in a learning cycle **activates** relevant prior knowledge. Learning is facilitated when the instruction directs learners to recall, relate, describe or apply knowledge from relevant past experience that can be used as a foundation for the new knowledge. If learners have limited prior experience, learning is facilitated when the instruction provided relevant experience that can be used as a foundation for the new knowledge.

Learning is facilitated when the next activity in a learning cycle **demonstrates** the new knowledge to be learned rather than merely telling information about what is to be learned. Too much instruction merely tells information. Information is usually general, abstract and refers to many specific situations. Learning is facilitated when instruction also shows portrayals of the information. Portrayals are representations of a specific cases that are concrete and that illustrate how the information applys to a single situation.

Learning is facilitated when the third activity in a learning cycle provides opportunity for the learner to **apply** the new knowledge to new specific situations. Application involves more than merely remembering information; it requires the learner to use the information to complete specific concrete tasks or to solve specific problems. Application involves solving whole problems or doing whole tasks and is more than merely answering questions about one step, one action or one event in the whole.

Finally a learning cycle is completed when learners have an opportunity to **integrate** the new knowledge and skill into their everyday activities. Learning is facilitated when the instruction provides an opportunity to publicly demonstrate their newly acquired knowledge and skill, when the instruction provides an opportunity to reflect on, discuss, or defend their new knowledge, and when the instruction provides an opportunity for the learners to creat, invent or explore new and personal ways to use their new knowledge and skill.

Perhaps as important as the 4-phase cycle of instruction is the notion that effective instruction is problem-centered, that is individual instructional components are most effectively taught in the context of a progression of real-world problems where the student is shown a problem, then taught the components, and then shown how the components are used to solve the problem or do the whole task. The Pebble-in-the-Pond approach to instructional design (Merrill,

2002b) prescribes worked problems early in the sequence of instruction and a gradual fading of this guidance or coaching as the instruction proceeds. Figure 2 illustrates this problem progression components instructional strategy.

First principles prescribes a problem-centered approach that combines the solving of problems with more direct instruction of problem components as contrasted with problem-based approaches in which students are placed in collaborative groups, given resources and a problem, and left to construct their own solution for the problem.

Most tasks or problems are complex aggregations of individual instructional components. Learning is facilitated when these components are directly taught in the context of a progression of whole problems or tasks. Too much instruction teaches the individual components or topics and leaves their integration to the student. Too often after a series of topics or components are taught the student is given a single task as a culminating experience and asked to use these components to solve the problem or complete the task. These typical topic-centered approaches are far less effective than an integrated approach that combines problem-centered instruction with direct instruction of the individual components.

While a number of different schemes for identifying instructional components have been proposed most include the following categories. The terms used here are more easily understood by subject matter experts than some of the more technical terms used by other schemes. Nevertheless, these simplified terms correspond sufficiently with previous knowledge classification schemes to allow specification of different demonstration and application conditions for each type of instructional component.

Most tasks or problems include the following instructional components: information-about, parts-of, kinds-of, how-to, and what-happens. Each of these components has a general

information element and one or more specific portrayal elements. The information and portrayal elements for each component category is indicated in the following table:

Learning outcome	Tell Information	Show Portrayal
information-about	facts or associations	not applicable
parts-of	name and description	location
kinds-of	definition	examples and non-examples
how-to	steps and sequence	illustration of steps for a specific cases
what-happens	describe process, conditions, consequences	illustration of specific conditions and consequences for specific cases

The demonstration and application applied to individual instructional components is not effective unless the information and portrayals involved are consistent with the type of component. Consistency means that the information and portrayals used correspond to the type of instructional component being taught. Consistency has been extensively described by Gagne (1985) and Merrill (1994).

In this paper I have attempted to gather empirically-verified prescriptive principles from several recent works and relate them to the outline of first principles. Rather than theories or models of instruction, as in my first paper, I selected sources that cited the research support for the prescriptive principles that we have cited here. As in the first review not all of these works include all of the principles. If a given heading contains no principles from the works we reviewed then it is because the source did not include a principle in this category in their list. None of these sources contained any contrary principles. Some of the principles cited provide

more detail than our statement of first principles. The principles were not transformed to correspond to the first principles but are quoted stated by their author. The reader is encouraged to study the original source for the principles listed. These sources include a description of the research support as well as application examples for the principles

In this synthesis the first principles are stated in question form. The reader of the previous work will note that there have been some modifications in some of the principles from their original publication. We have also added a section on implementation to include prescriptions that reviewers of our work have often cited as an omission.

Synthesis of First Principles

Problem-centered (Let me do the whole task!)

- ☆ Does the instruction involve authentic real-world problems or tasks?
  - "Interactions should mirror the job (p. 53)." (R. C. Clark & Mayer, 2003)
  - "Use job contexts to teach problem solving processes (p. 251)." (R. C. Clark & Mayer, 2003)
  - "Focus training on thinking processes versus job knowledge (p. 256)." (R. C. Clark & Mayer, 2003)
  - "Incorporate job-specific problem-solving processes (p. 264)." (R. C. Clark & Mayer, 2003)

- ☆ In place of a formal objective, does the instruction show the learners the whole task they will be able to do or the whole problem they will be able to solve as a result of completing the instruction?
  - " When instruction provides clear (to the learner) and complete procedural 'how to' examples of the decisions and actions needed to solve problems and perform necessary tasks to be learned, then learning and transfer will be increased (p. 16)." (R. E. Clark, 2003)
  - "Instructional goals narrow what students focus on (p. 94)." (Marzano, Pickering, & Pollock, 2001) Note this is probably because most objectives are component or topic oriented rather than whole task or whole problem oriented.
  - "Instructional goals should not be too specific (p. 94)." (Marzano et al., 2001) Note that when objectives are very specific they are usually topic-oriented rather than whole task oriented. Sometimes objectives are specific to only one instance of a task rather than to a class of tasks.
  - "Begin a lesson with a short statement of goals." (Rosenshine, 1997) Note this is the classic prescription. Rosenshine cites research showing goals are better than no goals. Clark's research shows that illustrating the task is better than formal objectives.

- ☆ Does the instruction teach the components of the problem or task and then help the learner use these components in solving the whole problem or doing the whole task? (See Figure 2 Instructional Sequence.)
  - "Students should practice the parts of a process in the context of the overall process (p. 142)." (Marzano et al., 2001)

- "Present new material in small steps, providing for student practice after each step." (Rosenshine, 1997). Note Rosenshine stresses teaching components is better than not teaching components but Marzano's findings indicate that it is still better when this component instruction is related to the whole task.

☆ Does the instruction involve a progression of problems not just a single application?

- "Use job-realistic or varied worked examples (p. 186)." (R. C. Clark & Mayer, 2003) Note that the emphasis here is on a varied sequence of job-related tasks rather than on a single task.

Activation (Where do I start?)

☆ Does the instruction direct learners to recall, relate, describe or apply prior knowledge from relevant past experience that can be used as a foundation for the new knowledge? If learners have limited prior experience, does the instruction provide relevant experience that can be used as a foundation for the new knowledge?

- "Cues and questions are ways that a … teacher helps students use what they already know about a topic. … Cues and questions should focus on what is important as opposed to what is unusual. … 'Higher level' questions produce deeper learning than 'lower level' questions. … Questions are effective learning tools even when asked before a learning experience (pp. 112-114)." (Marzano et al., 2001)
- "… providing cues to encourage learners to activate relevant preexisting knowledge facilitates learning (p. 246)." (Andre, 1997)
- "Help students develop their background knowledge." (Rosenshine, 1997)
- "Review. … relevant previous learning … prerequisite skills and knowledge." (Rosenshine, 1997)

☆ Does the instruction help learners see its relevance and to have confidence in their ability to acquire the knowledge and skill to be taught?

- "Designers can help students to become actively engaged in a course or lesson and to persist or stay "on track" when distracted by helping students connect their personal goals and interests to course goals, by clearly communicating the utility of the course goals (and the risk of not achieving them), and by helping students maintain their confidence in achieving the course goals (by pointing out past successes with similar goals) (p. 20)." (R. E. Clark, 2003)
- "… simply demonstrating that added effort will pay off in terms of enhanced achievement actually increases student achievement (p. 51)." (Marzano et al., 2001)
- "Students should be encouraged to personalize the teacher's goals (p.94)." (Marzano et al., 2001)

☆ Does the instruction provide or encourage the recall of a structure that can be used to organize the new knowledge?

- "Representing similarities and differences in graphic or symbolic form enhances students' understanding of and ability to use knowledge (p. 16)." (Marzano et al., 2001)
- "Being aware of the explicit structure of information is an aid to summarizing information (p. 32). (Marzano et al., 2001)
- "Graphic organizers are perhaps the most common way to help students generate nonlinguistic representations (p. 75). … The more we use both systems of representation – linguistic and nonlinguistic – the better [learners] are able to think about and recall knowledge (p. 73)." (Marzano et al., 2001)
- "Advance organizers should focus on what is important as opposed to what is unusual. … 'Higher level' advance organizers produce deeper learning than the 'lower level' advance organizers. … Advance organizers are most useful with information that is not well organized (p. 118)."

(Marzano et al., 2001) "… concrete AOs [advance organizers] seem to be more effective than more abstract AOs (p. .248)." (Andre, 1997)

- "Providing learners with a conceptual model can facilitate the acquisition of problem-solving skills …(p. 247)" (Andre, 1997)
- "… providing students with appropriate maps and diagrams has been shown to enhance their learning. … Concept or semantic mapping has promise of helping students acquire the interrelationships component of a knowledge domain (p. 253). " (Andre, 1997)
- "Provide and Teach a Checklist." (Rosenshine, 1997)

Demonstration (Don't just tell me, show me!)

☆ Does the instruction demonstrate (show examples of) what is to be learned rather than merely telling information about what is to be learned?

- "Replace some practice problems with worked examples (p. 177) ." (R. C. Clark & Mayer, 2003)
- "… examples in teaching concepts, principles, and problem-solving procedures … [result in] substantial benefits. … presenting learners with worked-out examples … led to more effective learning…(p. 255) " (Andre, 1997)
-

☆ Are the demonstrations (examples) consistent with the content being taught?

- Are there examples and non-examples for kinds-of (concepts)?

- "New concepts should be 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. If new concepts are presented with these supports, learning of concepts is enhanced. If highly novel applications of the concept are required, then provide practice on many different novel examples of the concept (p. 24)." (R. E. Clark, 2003)
- "In teaching concepts or classification skills, it is important to provide students with a range of examples of particu7lar concepts and also to provide contrasts between examples of closely related concepts (p. 256). (Andre, 1997).
- "… instruction should activate misconceptions and then induce learners to be in a state of disequilibrium or dissatisfaction about the misconception (p. 257)." (Andre, 1997) Note that one role of nonexamples is to allow a student to see where the information does not apply or where they may have mistakenly thought it applied when it does not. This principle is an elaboration of the examples and nonexamples prescription.

- Are there demonstrations for how-to (procedures)?

- "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 a worked example and the opportunity for part-whole practice that is scaffolded to reflect the learner's prior knowledge and 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 (p. 30)." (R. E. Clark, 2003)

- Are there visualizations for what-happens (processes)?

- "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 (p. 26)." (R. E. Clark, 2003)

- "When teaching causal principles, the more that the instructional presentation provides a statement about the cause and resulting effects, provides instruction using a worked, prototypical example drawn from the application setting, and helps the learner to first elaborate the elements and sequence of the causal chain and then to apply it to gradually more novel and complex examples, the more effective will be the learning and transfer to the job (p.28)." (R. E. Clark, 2003)

☆ Are some of the following learner guidance techniques employed?

- Is learner's attention is directed to relevant information?

- "People learn better from narrated animations when the narration highlights the key steps and the links between them (p. 47)." (Mayer, 2003)
- "Presenting students with explicit guidance in identifying similarities and differences enhances students' understanding of and ability to use knowledge (p. 15)." (Marzano et al., 2001)
- Asking students to independently identify similarities and differences enhances students' understanding of and ability to use knowledge (p. 15)." (Marzano et al., 2001)
- "… use of signaling devices generally has positive effects on memory for the presented information (p. 255)." (Andre, 1997)

- Are multiple representations are included and explicitly compared?

- "Visual representation of text material is helpful in improving comprehension of complex material (p. 60)." (Dembo & Young, 2003)
- " People learn better from corresponding words and graphics (e.g., animation, video, illustrations, pictures) than from words alone (p. 51, p. 37)." (R. C. Clark & Mayer, 2003; Mayer, 2003)
- "The more we use both systems of representation – linguistic and nonlinguistic [graphic] – the better we are able to think about and recall knowledge (p. 73)." (Marzano et al., 2001)
- "People learn better when corresponding words and graphics are placed near rather than far from each other on the screen (p. 67, p. 49)." (R. C. Clark & Mayer, 2003; Mayer, 2003)
- " People learn better when corresponding animation and narration segments are presented simultaneously (p. 51)." (Mayer, 2003)

- Are learners are assisted to relate the new information to the structure that was recalled or provided?

- "Teach learners to self-explain examples (p. 190)." (R. C. Clark & Mayer, 2003) Note if this self explanation assists learners to relate the new information to previously learned information or the structure that was recalled or provided then it will facilitate learning.
- "Make learners aware of their problem-solving processes (p. 260)." (R. C. Clark & Mayer, 2003) Note that the processes that facilitate learning are those that help the student relate previous knowledge to new knowledge or to the structure that was provided.
- "[Use] a variety of structured tasks to guide students through generating and testing hypotheses (p. 106)." (Marzano et al., 2001) Note testing hypotheses is another way to relate specific cases to general information.
- "… relating to-be-learned instructional events to preexisting knowledge … leads to superior learning and performance (p. 250)." (Andre, 1997)
- "Give clear and detailed instructions and explanations." (Rosenshine, 1997)

☆ Are the media relevant to the content and used to enhance learning?

- "Present words as speech rather than onscreen text (p. 86)." (R. C. Clark & Mayer, 2003)

- "People learn better from animation and narration than from animation, narration, and on-screen text (p. 45)." (Mayer, 2003) "Avoid presenting words as narration and identical text in the presence of graphics (p. 99)." (R. C. Clark & Mayer, 2003)
- " People learn better from narrated animations when the narration has a human voice with a standard accent rather than a machine voice or an accented voice (p. 53)." (Mayer, 2003)
- "People learn better from multimedia messages when extraneous words, pictures, and sounds are excluded rather than included (p. 33)." (Mayer, 2003) "Avoid e-Lessons with extraneous sounds, … extraneous pictures, … extraneous graphics or … extraneous words (pp. 111-126)." (R. C. Clark & Mayer, 2003)

Application (Let me do it!)

☆ Do learners have an opportunity to practice and apply their newly acquired knowledge or skill?

- "Critical tasks require more practice (p. 159)." (R. C. Clark & Mayer, 2003)
- "Provide a high level of active practice for all students." (Rosenshine, 1997)
- "Ask a large number of questions, check for student understanding, and obtain responses from all students." (Rosenshine, 1997)

☆ Are the application (practice) and assessment (tests) **consistent** with the stated or implied objectives?

  - Does information-about (factual information) practice require learners to recall or recognize information?
  - Does parts-of practice require learners to locate, name, and/or describe each part?
  - Does kinds-of (concept) practice require learners to identify new examples of each kind?

- "Asking students to apply taught concepts to new examples facilitates students' acquisition or construction of the concept (p. 251)." (Andre, 1997)
  - Does how-to (procedure) practice require learners to do the procedure?
  - Does what-happens (process) practice require learners to predict a consequence of a process given conditions, or to find faulted conditions given an unexpected consequence?

☆ Is the practice followed by **corrective feedback** and an indication of progress not just right-wrong feedback?

- "Effective feedback about learning progress results in better learning and transfer of such learning to the work environment (p. 18)." (R. E. Clark, 2003)
- "Feedback should be 'corrective' in nature. … simply telling students that their answer on a test is right or wrong has a negative effect on achievement. … The best feedback appears to involve an explanation as to what is accurate and what is inaccurate in terms of student responses (p. 96)." (Marzano et al., 2001)
- "Feedback should be specific to the criterion (p. 98)." (Marzano et al., 2001)
- "Provision of [feedback] typically results in superior performance on later tests than no [feedback] and providing the correct response is usually more effective than simply saying right or wrong (p. 259) ." (Andre, 1997)

- "Provide systematic feedback and corrections." (Rosenshine, 1997)

☆ Does the application or practice enable learners to access context sensitive help or provide **coaching** when they are having difficulty in solving the problem or doing the task? Is coaching gradually **diminished** with each subsequent task until learners are performing on-their-own?

- "Use onscreen coaches to promote learning (p. 138)." (R. C. Clark & Mayer, 2003)
- "Guide students during initial practice. … Provide Procedural Prompts or Facilitators **…** Provide models of appropriate responses … Think Aloud as Choices are Being Made. … Anticipate and Discuss Potential Difficulties. … Regulate the Difficulty of the Material. … Provide a Cue Card." (Rosenshine, 1997)
- "When teaching higher-level tasks, support students by providing them with cognitive strategies.. … Help students learn to use the cognitive strategies by providing them with procedural prompts and modeling the use of these procedural prompts." (Rosenshine, 1997)
- "Increase Student Responsibilities." (Rosenshine, 1997)

☆ Does the instruction require learners to use their new knowledge or skill to solve a **varied sequence** of problems or complete a varied sequence of tasks?

- Use a variety of structured tasks (p. 106). (Marzano et al., 2001)

Integration (Watch me!)

☆ Does the instruction provide techniques that encourage learners to integrate (transfer) the new knowledge or skill into their everyday life?

☆ Does the instruction provide an opportunity for the learner to publicly **demonstrate** their new knowledge or skill?

☆ Does the instruction provide an opportunity for learners to **reflect**-on, discuss, and defend their new knowledge or skill?

- "The process of explaining their thinking helps students deepen their understanding of the principles they are applying (p. 105)." (Marzano et al., 2001)

☆ Does the instruction provide an opportunity for learners to **create**, invent, or explore new and personal ways to use their new knowledge or skill?

Implementation

☆ Does the instruction facilitate learner **navigation** through the learning task?

- Use links sparingly to augment the lesson (p. 239). (R. C. Clark & Mayer, 2003) Note too many links may lose the learner in hyper space and make it difficult to navigate through the primary lesson material.
- Allow learners to control pacing (p. 240). (R. C. Clark & Mayer, 2003)
- Use course maps to provide an overview and orient learners (p. 241). (R. C. Clark & Mayer, 2003)
- Provide navigation options on all screens (p. 241). (R. C. Clark & Mayer, 2003)
- Make important instructional events the default navigation option (p. 236). (R. C. Clark & Mayer, 2003)

☆ Is the degree of **learner-control** appropriate for the learning goals and your learners?

- "Use learner control for learners with high prior knowledge or high metacognitive skills (p. 234)." (R. C. Clark & Mayer, 2003)
- "Add advisement to learner control (p. 238)." (R. C. Clark & Mayer, 2003)
- "As the extent of learner control increases, learning decreases except for a very small number of the most advanced expert learners (p. 14)." (R. E. Clark, 2003)

☆ Is **collaboration** used effectively?

- "Make assignments that require collaboration among learners (p. 207)." (R. C. Clark & Mayer, 2003)
- Assign learners to heterogeneous groups (p. 208). (R. C. Clark & Mayer, 2003) "Organizing groups based on ability levels should be done sparingly (p. 87)." (Marzano et al., 2001)
- "Structure group assignments around products or processes (p. 208)." (R. C. Clark & Mayer, 2003)
- "Cooperative groups should be kept rather small [3 or 4 members] in size (p. 88)." (Marzano et al., 2001)

☆ Is the instruction **personalized**?

- "People learn better from multimedia lessons when the words are in conversational style rather than formal style (p. 39)." (Mayer, 2003). "Use conversational rather than formal style (p. 133)." (R. C. Clark & Mayer, 2003)

The Activation, Guidance, Integration Cycle

The cycle of instruction identified for first principles suggested two layers of relationship. On the surface first principles identify learning activities that should be included in effective instruction: activation, demonstration, application and integration. At a deeper level there is within this cycle a more subtle cycle consisting of a structure – guidance – coaching – reflection cycle.

> "In general, research has demonstrated that making students aware of specific structure in information helps them summarize that information [and subsequently be able to remember and use this information more effectively]" (p. 32) (Marzano et al., 2001). (Rosenshine, 1997) describes the importance of well-connected knowledge structures. "Asking students to organize information, summarize information or compare new

material with prior material are all activities that require processing and should help students develop and strengthen their cognitive structures."

During the activation phase first principles prescribe that students should be encouraged to recall relevant knowledge or skills, or the instruction should provide an organizing structure based on what students already know. This structure should then be used to facilitate the acquisition of the new knowledge. Guidance is often not well defined but it is suggested that one primary purpose of guidance is to help the student relate the new material to the structure provided during the activation phase. During the application phase one primary role of coaching is to help students use this structure to facilitate their application activities. During the integration phase first principles prescribes reflection. During reflection students should be guided to summarize what they have learned and again examine how the new knowledge is related to what they previously knew via the structure that was recalled or provided. It is interesting to note that many of the courses we have critiqued on the basis of first principles fail to include activation or integration in any form so the use of guidance or coaching to relate new material to previously learned material via some structure is therefore not included. This deeper structure – guidance – coaching – reflection cycle as an integrated cycle of instructional events deserves more study and research.

Conclusion

It would appear from the limited sources quoted in this paper that first principles are not only common to and prescribed by many instructional design theories and models, but that they are also consistent with empirical research on instruction. It is hoped that as instructional design matures that this set of first principles can form a foundation on which future instructional design models and prescriptions can build. These principles are deliberately general and their

implementation can take many forms. These principles do not require the adoption of any particular philosophical –ism. First principles can be found in some form in almost all instructional design theories and models. We have not identified any principles that are contrary to these first principles. And yet, with this general agreement on fundamental foundational principles of instruction, many of the instructional products we have reviewed fail to implement even the first level of these principles, i.e., these products often fail to provide sufficient demonstration of worked examples, often fail to provide appropriate practice beyond remember-what-you-were-told questions, and seldom are centered in real-world problems. Few instructional products implement the activation and integration phases. Even fewer instructional products implement the next level of first principles by providing demonstrations and practice that are consistent with a variety of different instructional outcomes. Almost none of the products we have reviewed involve a structure-guidance-coaching-reflection cycle. If these are the first principles of instruction let's hope that they will become more widely applied thereby resulting in instruction that is more effective, efficient and appealing.

Study Guide for First Principles of Instruction

For an overview of First Principles of Instruction:

Merrill, M. David (2002). First principles of instruction. *Educational Technology Research and Development.* 50(3), 43-59.

Merrill, M. David (2002). A pebble-in-the-pond model for instructional design. *Performance Improvement.* 41(7), 39-44.

McCarthy, Bernice (1996). *About Learning*. Barrrington, IL: Excel, Inc.

The following text is perhaps the best advanced presentation of an instructional design model consistent with First Principles of Instruction:

van Merriënboer, Jeroen J. G. (1997). Training Complex Cognitive Skills: A Four-Component *Instructional Design Model for Technical Training*. Englewood Cliffs, NJ: Educational Technology Publications.

References

Andre, T. (1997). Selected Microinstructional Methods to Facilitate Knowledge Construction: Implications for Instructional Design. In R. D. Tennyson, F. Schott, N. Seel & S. Dijkstra (Eds.), *Instructional Design: International Perspective* (Vol. 1, pp. 243-267). Mahwah NJ:: Lawrence Erlbaum Associates.

Clark, R. C., & Mayer, R. E. (2003). *E-Learning and the Science of Instruction*. San Francisco: Jossey-Bass Pfeiffer.

Clark, R. E. (2003). What Works in Distance Learning: Instructional Strategies. In H. F. O'Neil (Ed.), *What Works In Distance Learning* (pp. 13-31). Los Angeles: Center for the Study of Evaluation.

Dembo, M., & Young, L. G. (2003). What works in distance education: learning strategies. In H. F. O'Neil (Ed.), *What Works in Distance Education*. Los Angeles: Center for the Study of Evaluation.

Gagne, R. M. (1985). *The Conditions of Learning and Theory of Instruction* (4th ed.). New York`: Holt, Rinehart and Winston.

Marzano, R. J., Pickering, D. J., & Pollock, J. E. (2001). *Classroom Instruction that Works: Research-based Strategies for Increasing Student Achievement*. Alexandria, VA: Association for Supervision and Curriculum Development.

Mayer, R. E. (2003). What Works in Distance Learning: Multimedia. In H. F. O'Neil (Ed.), *What Works in Distance Learning*. Los Angeles: Center for the Study of Evaluation.

Merrill, M. D. (1994). *Instructional Design Theory*. Englewood Cliffs, NJ: Educational Technology Publications.

Merrill, M. D. (2002a). First principles of instruction. *Educational Technology Research and Development, 50*(3), 43-59.

Merrill, M. D. (2002b). A pebble-in-the-pond model for instructional design. *Performance Improvement, 41*(7), 39-44.

Rosenshine, B. (1997). Advances in research on instruction. In E. J. Lloyd, E. J. Kameanui & D. Chard (Eds.), *Issues in Educating Students with Disabilities* (pp. 197-221). Mahwah, NJ: Lawrence Erlbaum.

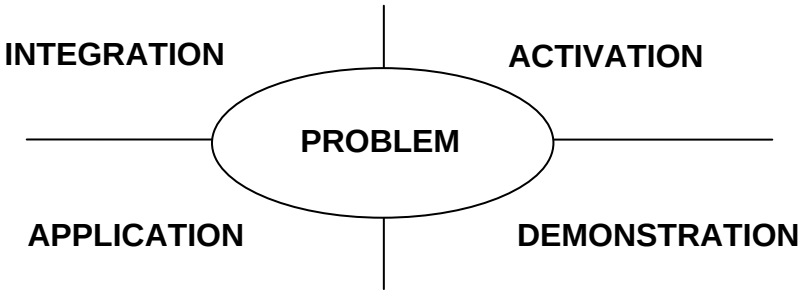

Figure 1 Phases of Effective Instruction

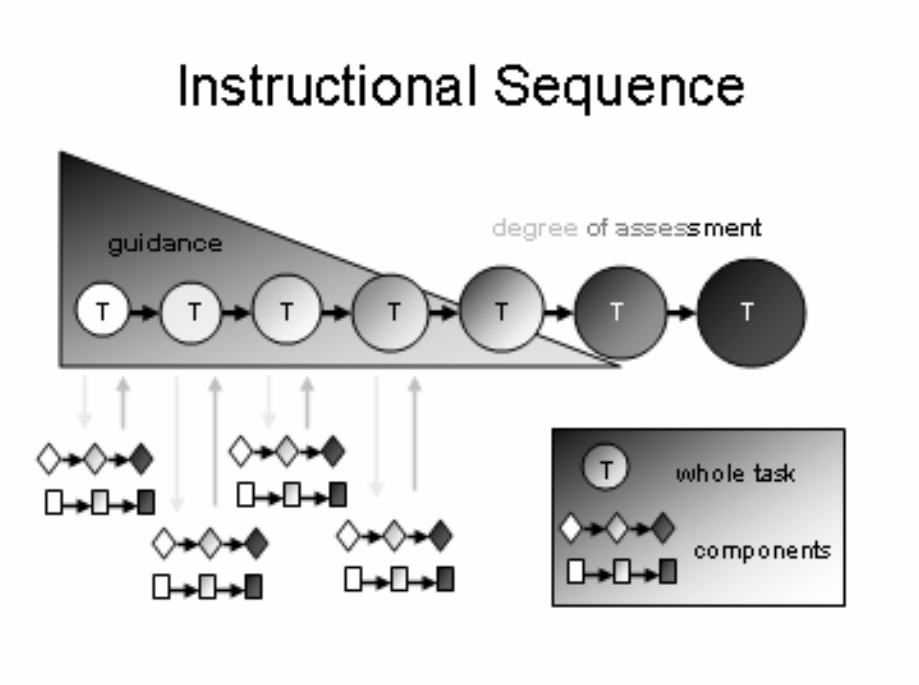

Figure 2 Instructional Sequence