Levels of Instructional Strategy[1]

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Abstract

This paper identifies a set of instructional strategy principles that have been prescribed by a number of different instructional theories and recommended practices. The author proposes that the successive application of these first principles of instruction define different levels of instructional strategy. Four levels of instructional strategy are described: information only, information plus demonstration, information plus demonstration plus application, and task-centered with demonstration and application. Five strategy enhancements are described: activation, structure, reflection, extrapolation, and going public.

Levels of Instructional Strategy

Introduction

Merrill (2002a; Merrill, 2002b, in press a, in press b) identified a set of instructional strategy principles that are prescribed by a number of different instructional theories and recommended practices. Table 1 lists these first principles of instruction.

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Insert Table 1 about here

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Are these principles of equal value? Do they contribute equally to learning effectiveness or efficiency? Are some of these principles more fundamental than others? How are these principles related to one another? What is the relative contribution of these principles to the acquisition of the skill and knowledge necessary to complete complex tasks? This paper suggests the relative contribution of these principles to performance on complex tasks. The successive application of these first principles of instruction defines increasingly effective levels of instructional strategy.

Levels of Performance on Complex Tasks

The principles identified in this paper are believed to facilitate learning in most instructional situations. However, the increased learning that results from these principles will probably not be detected by assessment techniques that require only recall of information. The performance enhancements promoted by first principles will be most evident in performance on complex tasks. Complex tasks require learners to produce an artifact or solve a problem. Such tasks require a variety of different kinds of knowledge and skill all brought together in an interrelated way(Gagne & Merrill, 1990; van

Merriënboer, 1997). Complex tasks allow for many levels of performance. At first the learner may only be able to complete simple versions of the task. As skill increases the learner can complete more and more complex versions of the task. In solving problems, early solutions may be unsophisticated and may consider only a portion of the factors involved. As the learner gains skill the solutions become more elegant, more complex and take into consideration more and more factors. Measurement of task performance must reflect this gradual acquisition of skill (See Bunderson, 2003).

What are some possible procedures for designing scaled measurement of performance level in complex tasks?

(1) Identify a progression of tasks, arranged so that the number or complexity of operations required for completion increases incrementally. For each task in the progression, establish a rubric of acceptable performance. The learner then completes the tasks in succession until they are unable to complete a task. Appropriate scoring measures the highest level in the progression of tasks at which the student completed the whole task in an acceptable manner.

(2) Learners are given a task with various levels of coaching available. When the learner is unable to proceed, the first level of coaching is provided. If the learner still has difficulty the second level of coaching is provided and so forth until the learner is able to complete the task. The score is an inverse of the amount of successively more elaborate coaching required for the student to solve the problem or complete the task. In this case it is not a progression of tasks that is scaled but the amount of help required within a task.

(3) It may be possible to use a single nested complex task to assess increasing levels of performance. This is similar to the task progression previously described but in this

situation solving the problem or completing the task can proceed incrementally. Each stage toward the complete solution requires an incremental increase in expertise. A student is scored on the number of stages completed toward the problem solution.

Levels of Instructional strategy

Instructional strategies can also be scaled so that the level of instructional strategy employed correlates with the level of effective and efficient performance on scaled complex tasks. The level of an instructional strategy is determined by the degree to which it implements first principles of instruction as described in the remainder of this paper (See Table 2).

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Level 0 Instructional Strategy – Information Only

Presenting only information is assumed to be the base-line (level 0) instructional strategy. Information-only includes presentation alone or presentation plus recall. An information presentation tells learners associations among two or more pieces of information; the name and description of one or more parts; the defining characteristics of a class of objects, situations, or processes; the steps and sequence to carry out a procedure; or the conditions and consequence for the events in a process. Recall asks learners to remember the information that was presented. Information-only instructional strategies are very common in all educational environments whether schools, industry or government. Information only instructional strategies are very efficient for conveying

large amounts of information but are ineffective in promoting performance on complex tasks.

Level 1 Instructional Strategy 1 -- Information-only plus demonstration

A *demonstration* is one or more worked examples of all or part of the task that shows how the information is applied to specific situations. To be effective the demonstration must be consistent with the kind of task: location with respect to the whole for parts; examples of the various categories for concepts; showing the execution of the steps together with the consequence for a procedure; and illustrating a specific process by showing the portrayal of the conditions and consequence (Merrill, 1997).

Information-only is stored in associative memory. Without a demonstration learners may fail to construct a schema or they may construct an incomplete or inadequate schema. When asked to apply the information in a new situation they do not have or cannot create an adequate mental model to complete the task.

This paper also proposes levels within levels for an instructional strategy. The following paragraphs suggest increments within a demonstration strategy. Appropriate *attention focusing guidance* directs attention to relationships among information and portrayals thus enabling learners to more readily relate abstract information to specific instances. Without this guidance learners often fail to see the relationships thus forming an incomplete schema or one that is difficult to generalize because they do not have the abstract information associated with the concrete example. In addition this guidance helps cognitive load by reducing the amount of effort required to locate critical relationships thus allowing more time for the learner to build appropriate schema and transfer the relationships to long term memory.

Graphic information that enhances and illustrates the information being presented facilitates learning. Graphic information that is irrelevant, (i.e. not directly related to the information being presented), increases cognitive load and results in a decrement in learning (Clark & Mayer, 2003; Mayer, 2001; Schnotz & Bannert, 2003).

Level 2 Instructional Strategy -- Information-only plus demonstration plus application

Application requires learners to use their knowledge or skill to accomplish specific tasks. Consistent application for *parts-of* tasks is to locate the part with respect to the whole; for *kinds-of* tasks is to sort examples into appropriate categories; for *how-to* tasks is to execute a series of steps; and for *what-happens* tasks is to predict a consequence given a set of conditions or find faulted conditions given an unexpected consequence.

Application allows learners to tune their schema. Given information plus consistent demonstration assists the learners to form an appropriate schema. Using this schema to do a new task requires them to check the completeness and adequacy of their schema. When errors result and these are followed by corrective feedback, then learners can adjust their schema. The initial application usually results in the most dramatic adjustment of the schema. If the schema is very incomplete or inadequate then learners may be unable to complete the task. If the task is too similar to tasks that were demonstrated then learners merely do the task but engage in very little reconstruction of their schema. The challenge is to find new tasks for application that challenge the student but are not so challenging that their schema is inadequate to complete the task.

Coaching means that the instructional system or instructor does some of the cognitive processing for the student. Such coaching often takes the form of hints. A

simple task may require only a single hint but complex tasks may require a series of more and more complete hints as described for determining level of performance on complex tasks as described in previous paragraphs.

If a task is too complex the student may be unable to complete the task causing discouragement and eroding confidence. It is not always possible to sequence tasks in an optimal progression of difficulty. In order for learners to complete the task the instructional system does some of the "thinking" for learners and allows them to complete the remainder of the task. If this coaching is always present learners exercise their right to be lazy and began to depend on the coaching rather than tuning their schema to be able to complete the task on their own. When confronted with a task that is not accompanied by coaching their previous reliance on hints has prevented sufficient schema development for them to complete the task. If this coaching is gradually withdrawn with each subsequent task the student is gently lead to rely more and more on their own resources to solve the problem or do the task. When the coaching is finally completely withdrawn learners will have sufficiently developed their own schema to allow them to complete the task without assistance.

Level 3 Instructional Strategy -- Task-centered with demonstration and application

A *task-centered approach* is not the same as problem-based learning or case-based learning as they are typically described in the instructional literature. A task-centered approach (see Figure 1) is much more structured. It involves presenting a specific complex whole task to the learners, demonstrating a successful completion of the task, providing information plus demonstration plus application for each of the instructional components required by the task, and then showing learners how these instructional

components apply to the task. It also involves a progression of successively more complex tasks with successively less guidance provided with each subsequent task until learners are completing the tasks on their own. The 4C/ID model represents a very sophisticated version of a task-centered instructional strategy (van Merriënboer, 1997).

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When instructional components are decontextualized students are often admonished with "You won't understand this now but later it will be very important to you." As a result the motivation to learn the material is significantly reduced. Further, when learners must retain many instructional components without a context for their use they must often resort to associative memory and are likely to forget or fail to recognize the relevance of the information when confronted with the whole task and thus be unable to retrieve the required information when it is needed. At best they will construct schema for the individual skills. They are unlikely to incorporate the component into a schema for the whole complex task. When instructional components are presented just-in-time for their application to a complex problem then the need for the knowledge or skill is apparent and the motivation to learn the knowledge or skill is increased. When the components are immediately applied to a complex problem then the student can construct a schema for the whole task rather than separate schemas for the individual instructional components.

A task-centered instructional strategy that consists of a single complex task may be an effective strategy but a single task is far less effective than a progression of

increasingly more complex tasks. A family of complex tasks, while sharing many similarities is also characterized by subtle differences. Learning to complete a single task leaves learners with only one view of the task and when confronted with a task from the same family but with differences from the original learning task they may fail to recognize that it is from the same family of tasks or they may not have sufficiently tuned their schema to enable them to adjust the solution process to accommodate the differences found in the task. If the training task is a less complex task than a new task then learners may have not developed the nuanced schema necessary to tackle the more complex task. A progression of tasks that is progressively more complex during training with the student performing more and more of the steps to task completion on their own enables them to tune their schema so that when confronted with yet a different or more complex task from the same family they are able to move forward toward task completion.

Enhancements of Instructional Strategy

Activation as an enhancement of an instructional strategy

Adding *activation* to an information-only strategy may promote an increment in performance if the student has developed relevant schema from the previous experience. This schema can then be used as the basis for the construction of revised schema given the information. The more familiar the new task is to previously learned tasks the larger the affect from activation of this previous learning. Unfamiliar new tasks, for which the previous experience is only tangentially related, are less likely to promote an increment in performance.

Adding *relevant-experience-activation* to level 1, level 2 or level 3 instructional strategies facilitates the formation of an appropriate schema by allowing learners to build on existing schema. On the other hand activating an inappropriate schema by activating experience that is not relevant may actually promote a decrement in performance.

Structure as an enhancement of an instructional strategy

One way to help students form an appropriate schema or mental model for completing a complex task is to provide a *framework* or *structure* that can be used to organize the information required. One form of such a structure is an advanced organizer (Mayer, 1984). Other forms of structure have also been suggested (Marzano, Pickering, & Pollock, 2001; Merrill, 2002d). This structure can form the basis for an appropriate task schema. When left to their own resources learners often use less effective structures for organizing the information. When the instructional system provides an effective structure that learners can use to store and process the information their ability to retrieve and use this information in subsequent situations is improved. Providing a structure is especially effective for students who may have had little or no relevant prior experience that can be used as a basis for a new schema for the family of tasks.

Reflection as an enhancement of an instructional strategy

It has often been demonstrated that amount and level of learning is a function of the amount of effort and time learners expend to acquire the required skill (e.g. Carroll, 1963). Providing an opportunity to *reflect*, review, go back over the information and portrayals of the information increases the level of effort, provides additional opportunity for solidifying an appropriate schema, and allows learners to explore areas of possible misconception or ambiguity. This additional effort provides a tuning for learners'

schema increasing the probability that it will be more effective in completing subsequent tasks.

Encouragment to extrapolate as an enhancement of an instructional strategy

Extrapolation of the skill is the opportunity for learners to think ahead to find ways that the newly acquired knowledge and skill might be applied in their subsequent real-world activities. Extrapolation probably is more related to long range transfer than to task performance immediately following instruction.

Going public as an enhancement to an instructional strategy

Engagement is only temporarily gained by graphics, animation, video, audio and other multimedia enhancements. These superficial qualities of an instructional program often do little or nothing to promote long term engagement. Learning itself is the most significant determiner of long term engagement. People love to learn but only when they can see their learning progress. When they perceive that they have acquired skill that was not present when they started the instruction then there is a desire to show what they have learned. Going public means that there is an opportunity to "show off" learning to significant others. Knowing that they will be going public early in the instruction provides an increased incentive for learners to be engaged in the learning process so that they will be able to effectively perform for others when the opportunity is presented. If learners are informed that they will be required to go public and if they cannot perceive learning progress, then engagement will turn to frustration or anxiety with a resulting decrement in learning effectiveness and efficiency.

Conclusion

This paper suggests that performance on complex tasks will be incremented when an instructional strategy implements each of the first principles in turn. Adding consistent demonstration to information promotes the first increment (level 1) in learning effectiveness, efficiency and engagement. Adding consistent application with corrective feedback to information with demonstration adds a second increment (level 2) in learning effectiveness, efficiency and engagement. Using a task-centered approach adds the third increment (level 3) in learning effectiveness, efficiency and engagement. Activation added to level 1, 2 or 3 will add an additional learning increment. Integration added to levels 2 or 3 will also add an additional learning increment.

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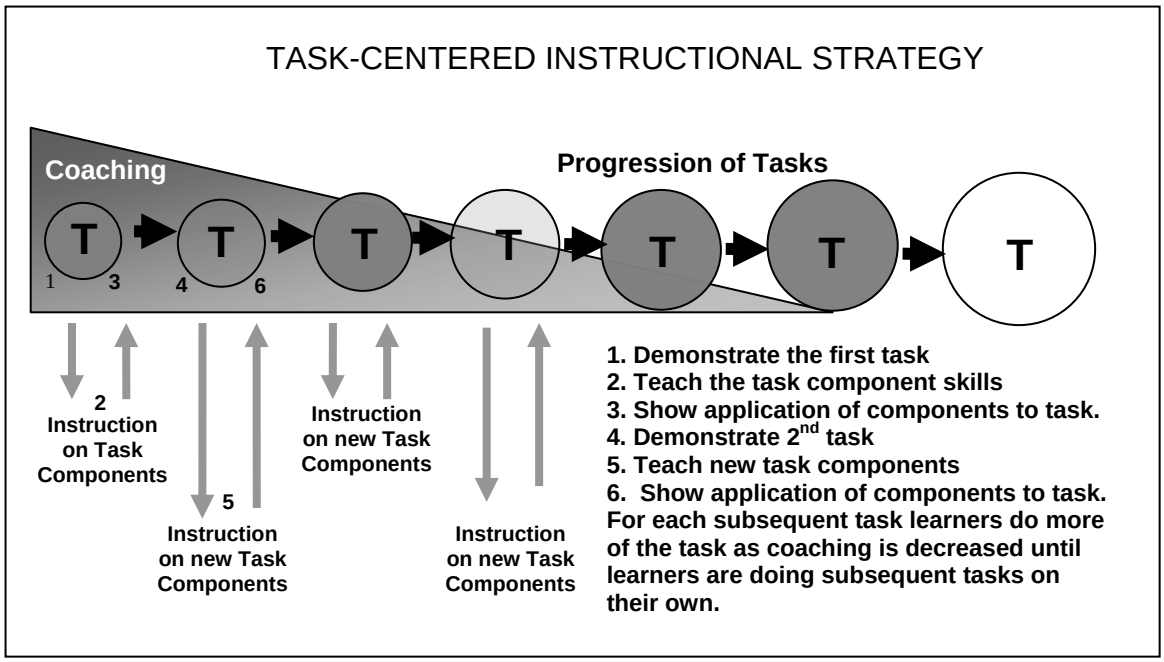

Figure 1 Task-Centered Instructional Strategy

Table 1
First Principles of Instruction

Demonstration principle

- Learning is promoted when learners observe a **demonstration** of the skills to be learned that is **consistent** with the type of content being taught.
- Demonstrations are enhanced when learners receive **guidance** that relates instances to generalities.
- Demonstrations are enhanced when learners observe **media** that is relevant to the content.

Application principle

- Learning is promoted when learners engage in **application** of their newly acquired knowledge or skill that is **consistent** with the type of content being taught.
- Application is effective only when learners receive intrinsic or corrective **feedback**.
- Application is enhanced when learners are coached and when this **coaching** is gradually withdrawn for each subsequent task.

Task-centered approach

- Learning is promoted when learners are engaged in a **task-centered** approach which includes demonstration and application of component skills.
- A task-centered approach is enhanced when learners undertake a **progression** of whole tasks.

Activation principle

- Learning is promoted when learners activate relevant cognitive structures by being directed to recall, describe or demonstrate relevant **prior knowledge** or experience.
- Activation is enhanced when learners recall or acquire a **structure** for organizing the new knowledge.

Integration principle

- Learning is promoted when learners **integrate** their new knowledge into their everyday life by being directed to reflect-on, discuss, or defend their new knowledge or skill.
- Integration is enhanced when learners create, invent, or **extrapolate** personal ways to use their new knowledge or skill to situations in their world.
- Integration is enhanced when learners **publicly demonstrate** their new knowledge or skill.

Table 2
Levels of Instructional Strategies

Level 0

A level 0 instructional strategy is the presentation of information with or without accompanying recall questions.

Level 1

A level 1 instructional strategy that adds consistent demonstration to a level 0 information-only-strategy promotes a higher level of performance on scaled complex tasks.

Adding learner guidance to demonstration promotes an additional increment in the level of efficient and effective performance on complex tasks.

Relevant media included in a demonstration promotes an additional increment in learning efficiency, effectiveness and engagement. Irrelevant media included in a demonstration results in a decrement in learning efficiency, effectiveness or engagement

Level 2

A level 2 instructional strategy that adds consistent application with corrective feedback to a level 1 instructional strategy consisting of information plus demonstration promotes an additional increment of performance on complex tasks.

Adding gradually diminishing coaching to application promotes an additional increment in learning efficiency, effectiveness and engagement.

Level 3

A level 3 instructional strategy that consists of a task-centered approach that includes consistent demonstration and application of component skills, promotes superior performance on complex tasks.

Adding task progression to a task-centered instructional strategy promotes an additional increment in learning efficiency, effectiveness and engagement.

Activation Enhancement

Providing or recalling relevant experience with any of the above instructional strategies promotes an additional increment in learning efficiency, effectiveness and engagement.

Structure Enhancement

Adding an activation-structure to any of the above instructional strategies promotes an additional increment in learning efficiency, effectiveness and engagement.

Reflection Enhancement

Adding reflection integration to any of the above instructional strategies promotes an additional increment in learning efficiency, effectiveness and engagement.

Extrapolation Enhancement

Adding extrapolate-integration to any of the above instructional strategies promotes transfer of the newly acquired knowledge and skill to performance on similar tasks in the real-world beyond the instructional situation.

Going Public Enhancement

Adding go public- integration to any of the above instructional strategies promotes increased engagement that in turn promotes an additional increment in learning efficiency and effectiveness.