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Using the First Principles of Instruction to Make Instruction Effective, Efficient, and Engaging

M. David Merrill

For over 50 years my career has been focused on one very important question: “What makes instruction effective, efficient, and engaging?” I decided that e-learning should refer to the quality of the instruction, not merely to how it is delivered, so I labeled effective, efficient, and engaging instruction as e3 instruction. In this brief presentation I will try to share a little of what I’ve learned. Perhaps the underlying message of my studies and this presentation is this simple statement: **“Information alone is not instruction!”**

In 1964, in our research lab at the University of Illinois, we were sending messages from one computer to another via ARPANET. Little did we realize the fantastic potential of this experimental communication from computer to computer. Unfortunately for our subsequent fortunes, none of us in that lab envisioned the Internet and the World Wide Web and the impact that this invention would have on communication, the availability of information, social interaction, commerce, education, and almost every other aspect of our lives.

“Information Alone is Not Instruction!”

In 1963, I was doing my student teaching in a junior high school; my subject was American history. Unfortunately for this experience, my major was psychology with a minor in mathematics. I never had an American history class in my entire college career. The students’ textbook was woefully inadequate, so I spent my evenings poring through the American Encyclopedia, which fortunately was resident in my home. This paucity of information left me very underprepared for teaching these students. However, thanks to the ongoing presidential election (Nixon vs Kennedy), there was a debate on television that I could use as a springboard to teach a little about the electoral process, the Electoral College, and something about our two-party system of government.

But today, thanks to the Internet, interested learners can find information about almost anything in the world, whether current events or historical events. Teaching American

history to junior high students today would be so much easier because of the almost unlimited amount of information in all different media that is available, including audio, video, animation, as well as text. But is access to this wealth of information instruction? What I've learned from my study of this question is that the answer is an emphatic NO! I repeat, **Information alone is not instruction**.

Motivation

All of us have heard the saying that "students didn't learn because they just weren't motivated." Or that "motivation is the most important part of learning." Or "we really need to find a way to motivate our students." What is it that causes motivation? People have often asked me, "Is motivation one of your first principles of instruction?" The answer is no; motivation is not something we can do, motivation is an outcome. So, if it is an outcome, what causes motivation? Motivation comes from learning; the greatest motivation comes when people learn. We are wired to learn; all of us love to learn; every student loves to learn. And, generally, we are motivated by those things that we find we are good at. For example, I'm not much of an athlete. I look back on my past and ask, "Why am I not an athlete?" I remember that I was very small as a child. In my elementary school we used to divide up into teams during recess to play softball. I always ended up as last shag on the girls' team. That was very embarrassing for me, so, I lost interest in sports; I did not want to be a sports person. Consequently, I never pursued sports. On the other hand, somewhere in my youth I was given a scale model train. I was very interested in trains, but in this case one of my father's friends showed me how to build scenery and how to make a model railroad that looked like the real world. I became very interested in building a model railroad. I have continued to follow this interest throughout my life. Why was I motivated to do this? Because I was good at it, because I learned things about how to build a realistic model. The more I learned, the more interested I became. We need to find ways to motivate our students, and that comes from promoting learning. Learning comes when we apply the effective and engaging principles of instruction.

Typical Instructional Sequence

In my experience I have had the opportunity to review many courses. Figure 1 illustrates a common instructional sequence that I have observed.

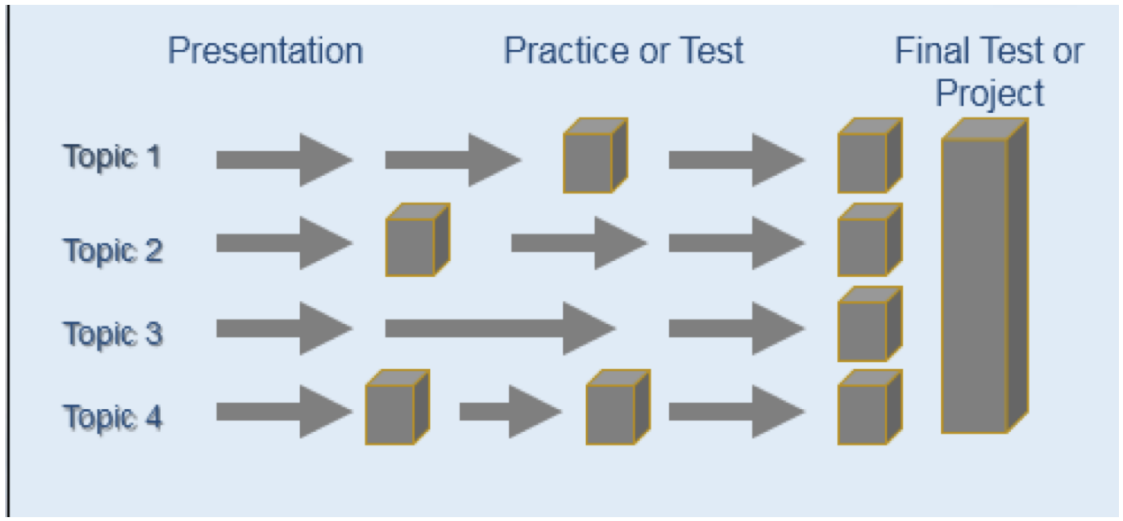

Figure 1. Typical Instructional Sequence

The course or module consists of a list of topics representing the content of the course. Information about the topic is presented, represented by the arrows. Occasionally a quiz or exercise is inserted to help illustrate the topic, represented by the boxes. The sequence is to teach one topic at a time. At the end of the course or module there is a culminating final test, or in some cases a final project, that asks the students to apply the topic to complete some t*ask* or solve some problem.

Sometimes this sequence is very effective in enabling students to gain skills or to learn to solve problems. Too often, however, this sequence is ineffective and not engaging for students. The effectiveness of this sequence and the degree of engagement it promotes for learners depends on the type of learning events that are represented by the arrows and the boxes in this diagram.

Instructional Events

There are many different types of instructional or learning events. Perhaps the most frequently used learning event is to present information or *Tell*. This *Tell* can take many forms, including lectures, videos, text books, and PowerPoint presentations.

The next most frequent instructional or learning event is to have learners remember what they were told, what they read, or what they saw. This remember instructional event we will label as *Ask*. Even though *Tell* and *Ask* are the most frequently used instructional events, if

they are the only instructional events used then the *Tell–Ask* instructional sequence is the least effective instructional strategy.

If the arrows in Figure 1 represent *Tell* learning events and the boxes represent *Ask* learning events, then this module is not going to be very effective and most likely will not prepare learners to adequately complete a project using the information taught. If the culminating learning activity is an *Ask* final exam, learners may be able to score well on this exam. However, a good score on an *Ask* exam does little to prepare learners to apply the ideas taught to the solution of a complex problem or completion of a complex t*ask*.

A little history is in order. In 1999 Charles Reigeluth published a collection of papers on Instructional Design Theories and Models. In the preface to this book he indicates that there are many different kinds of instructional theories and that instructional designers need to be familiar with these different approaches and select the best approach or combination of approaches that they feel are appropriate for their particular instructional situation. I challenged Dr. Reigeluth, suggesting that while these different theories stressed different aspects of instruction and used different vocabulary to describe their model and methods, that fundamentally, at a deep level, they were all based on a common set of principles. Dr. Reigeluth kindly suggested that he didn't think that my assumption was correct, but if I felt strongly about it that perhaps I should try to find evidence for my assumption.

I took the challenge and spent the next year or two studying these various instructional theories. The result was the publication in 2002 of my often-referenced paper on First principles of Instruction (Merrill, 2002). I have spent the time since in refining my proposition in a series of papers and chapters on First Principles. In 2013, I finally published my book *First Principles of Instruction* (Merrill, 2013) that elaborated these principles, provided a set of suggestions for how these principles might be implemented in various models of instruction, and provided a variety of instructional samples that illustrate the implementation of First Principles in a range of content areas and in different educational contexts, including training, public schools, and higher education.

First Principles of Instruction

Principles are statements of relationships that are true under appropriate conditions. In instruction these relationships are between different kinds of learning events and the effect that participating in these learning events has on the acquisition of problem-solving skills. I identified five general principles that comprise First Principles of Instruction. As I reviewed the literature on instructional design theories and models, I tried to be as parsimonious as possible by selecting only a few general principles that would account for the most fundamental learning activities that are necessary for effective, efficient, and engaging instruction.

Activation: Learning is promoted when learners activate a mental model of their prior knowledge as a foundation for new skills. A frequently cited axiom of education is to start

where the learner is. Activation is the principle that attempts to activate a relevant mental model already acquired by the learner in order to assist him or her to adapt this mental model to the new skills to be acquired.

Demonstration: Learning is promoted when learners observe a demonstration of the skills to be learned. I carefully avoided the word presentation for this principle. Much instruction consists largely or entirely of presentation. What is often missing is demonstration, show me. Hence, the demonstration principle is best implemented by *Tell–Show* learning events where appropriate information is accompanied by appropriate examples.

Application: 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. Way too much instruction uses remembering information as a primary assessment tool. But remembering information is insufficient for being able to identify newly encountered instances of some object or event. Remembering is also insufficient to be able to execute a set of steps in a procedure or to grasp the events of a process. Learners need to apply their newly acquired skills to actually doing a t*ask* or actually solving a problem.

Integration: Learning is promoted when learners share, reflect on, and defend their work by peer-collaboration and peer-critique. Deep learning requires learners to integrate their newly acquired skills into those mental models they have already acquired. One way to insure this deep processing is for learners to collaborate with other learners in solving problems or doing complex tasks. Another learning event that facilitates deep processing is when learners go public with their knowledge in an effort to critique other learners or to defend their work when it is critiqued by other learners.

Problem-centered: Learning is promoted when learners are engaged in a problem-centered strategy involving a progression of whole real-world *task*s. The eventual purpose of all instruction is to learn to solve complex problems or complete complex tasks, either by themselves or in collaboration with other learners. This is accomplished best when the problem to be solved or the *task* to be completed is identified and demonstrated to learners early in the instructional sequence. Subsequent component skills required for problem solving or for completing a complex task are best acquired in the context of trying to solve a real instance of the problem or complete a real instance of the task.

Support for First Principles of Instruction

Do First Principles of Instruction actually promote more effective, efficient, and engaging instruction?

A study conducted by NETg (Thompson Learning, 2002), a company that sells instruction to teach computer applications, compared their off-the-shelf version of their Excel instruction, which is topic-centered, with a problem-centered version of this course that was developed following First Principles. Participants in the experiment came from a number of different companies that were clients of NETg. The assessment for both groups consisted of

developing a spreadsheet for three real-world Excel problems. The problem-centered group scored significantly higher, required significantly less time to complete the problems, and expressed a higher level of satisfaction than the topic-centered group. All differences were statistically significant beyond the .001 level.

A doctoral student at Florida State University completed a dissertation study comparing a topic-centered course teaching Flash programing with a problem-centered course (Rosenberg-Kima, 2011). This study was carefully controlled so that the variable was merely the arrangement of the skill instruction in the context of problems or taught skill-by-skill. The learning events for both groups were identical except for the order and context in which they were taught. On a transfer Flash problem that required students to apply their Flash programing skills to a new problem, the problem-centered group scored significantly higher than the topic-centered group and felt the instruction was more relevant and resulted in more confidence in their performance. There was no time difference between the two groups for completing the final project.

A professor at Indiana University designed a student evaluation questionnaire that had students indicate whether the course being evaluated included First Principles of Instruction (Frick, Chadha, Watson, & Zlatkovska, 2010). The correlations all showed that the extent to which First Principles are included in a course correlates with student rating of instructor quality and their rating of satisfaction with the course. Students also spent more time on task and were judged by their instructors to have made more learning progress when the courses involved First Principles of Instruction. This data was collected in three different studies.

The conclusion that can be drawn from these three different and independent studies of First Principles clearly shows that courses based on First Principles do facilitate effectiveness, efficiency, and learner satisfaction.

Demonstration Principle

When I’m asked to review course material, my approach is to immediately turn to Module 3 of the material. By then the course is usually into the heart of the content, and the introductory material is finished. What do I look for first? Examples. Does the content include examples, demonstrations, or simulations of the ideas being taught? Adding demonstration to a course will result in a significant increment in the effectiveness of the course.

Do most courses include such demonstration? MOOCs are a recent very popular way to deliver instruction. How well do these *Massive Open Online Courses* implement First Principles of Instruction? Anoush Margaryan and her colleagues (Margaryan, Bianco, Littlejohn, 2015) published an important paper titled Instructional Quality of Massive Online Courses (MOOCs) that addresses this question. They carefully analyzed 76 MOOCs representing a wide variety of content sponsored by a number of different institutions to determine the extent that these courses implemented First Principles of Instruction. Their

overall conclusion was that most of these courses failed to implement these principles.

The demonstration principle, providing examples of the content being taught, is fundamental for effective instruction and engaging instruction. How many of these MOOCs implemented this principle? Only 3 out of the 76 MOOCs analyzed included appropriate demonstration. The effectiveness and engagement in these MOOCs could be significantly increased by adding relevant and appropriate demonstration.

Application Principle

When I'm asked to review a course, the second type of learning event I look for is application that is consistent with and appropriate for the type of learning involved. Remembering a definition or series of steps is not application. There are two types of application that are most important but too often not included. *DOid* or *DOidentify* requires learners to recognize new divergent examples of an object or event when they encounter it. *DOidentify* is also the initial application required when learning the steps of a procedure or process. The learner must first recognize a correctly executed step when they see it, and they must also recognize the consequence that resulted from the execution of the step. Once they can recognize appropriate steps and appropriate consequences for these steps, then *DOexecute* is the next level of application. *DOexecute* requires learners to actually perform or execute the steps of a procedure. When appropriate application is missing, the effectiveness of a course is significantly increased when appropriate application learning events are added.

MOOCs are often about teaching learners new skills. Did the MOOCs in the study cited above include appropriate application for these skills? They fared better than they did for demonstration. At least 46 of the 76 MOOCs did include some form of application. This still leaves 30 MOOCs in this study without application of any kind. However, on careful analysis of the sufficiency and appropriateness of the application included, it was found that only 13 of the MOOCs in this study had appropriate and sufficient application.

Learning Events

While *Tell* and *Ask* are the most frequently used learning events, as we have seen, a strategy that uses only these two learning events is not an effective or engaging strategy. Learning to solve problems and to do complex tasks is facilitated when a *Tell* instructional strategy is enhanced by adding demonstration or *Show* learning events. A *Tell-Show* sequence is more effective than a *Tell* only sequence.

Learning to solve problems and to do complex tasks is facilitated even more when a *Tell-Show* strategy is further enhanced by adding *Do* instructional events. These *Do* learning events are most appropriate when they require learners to identify unencountered instances of some object or event (*DOidentify* learning events) and when they require learners to execute the steps in a procedure or observe the steps in a process (*DOexecute* learning events). A *Tell-Show-Do* sequence is even more effective than a *Tell-Show* instructional

sequence.

Much existing instruction can be considerably enhanced by the addition of appropriate *Show* and *Do* learning events. If the arrows in Figure 1 consist of *Tell* and *Show* learning events and the boxes consist of *Do* learning events and if the final project is not merely a remember or *Ask* assessment but the opportunity for learners to apply the skills they have acquired from the *Tell-Show-Do* instruction to a more complete problem or task, then the resulting learning will be more effective, efficient, and engaging for learners. Much existing instruction can be significantly enhanced by converting from *Tell-Ask* learning events in this typical instructional sequence to *Tell-Show-Do* learning events.

How to Revise Existing Instruction

Much existing instruction is primarily *Tell-Ask* instruction. This instruction can be significantly enhanced by the demonstration of appropriate examples (*Show* learning events) and even further enhanced by the addition of appropriate application activities (*Do* learning events).

The fundamental instructional design procedure to enhance existing instruction is fairly straightforward. Start by identifying the topics that are taught in a given module. Create a matrix and list these topics in the left column of a matrix. Across the top of the matrix list the four primary learning event types: *Tell, Ask, Show, and Do.*

Second, identify the *Tell* information for each topic and reference it in the *Tell* column. Review this information to ensure that each topic is accurate and sufficient for the goals of the instruction.

Third, identify existing *Show* learning events for each topic. If the existing instruction does not include appropriate or sufficient examples of each of the concepts, principles, procedures, or processes listed, then identify or create appropriate examples for inclusion in the module. Creating a matrix to use as a cross reference for the new content examples can help identify areas where new activities need to be placed in the course.

Fourth, identify existing *Do* learning events for each topic. If the existing instruction does not include appropriate or sufficient *Do* learning events, then identify or create appropriate *Do-identify* or *Do-execute* learning events for inclusion in the module.

Finally, assemble the new demonstrations and applications into the module for more effective, efficient, and engaging instruction.

The Context Problem

Even after appropriate demonstration and application learning events are added to this traditional instructional sequence, there is still a potential problem that keeps this instructional sequence from being as effective, efficient, and engaging as possible. In this

sequence topics are taught one-on-one. The demonstration and application learning events added to a *Tell* sequence are usually examples that apply to only a single component skill and are merely a small part of solving a whole problem. Too often learners fail to see the relevance of some of these individual skills learned out of context. We have all experienced the often used explanation: “You won’t understand this now, but later it will be very important to you.” If “later” in this situation is several days or weeks there is a good possibility that the learners will have forgotten the component skill before they get to actually use this skill in solving a whole problem or doing a whole task. Or, if learners do not see the relevance of a particular skill they may fail to actually learn the skill or they are unable to identify a mental model into which they can incorporate this skill. Then, when it is time to use this skill in the solution of a whole problem, learners are unable to retrieve the skill because it was merely memorized rather than understood. Furthermore, if solving a whole problem or doing a whole task is the final project for a module or course, there may be no opportunity to get feedback and revise the project.

Is there a better sequence that is more effective, efficient, and engaging than this typical sequence?

Problem-centered

To maximize engagement in learning a new problem solving skill, learners need to acquire these skills in the context of the problem they are learning to solve or the task they are learning to complete. If learners first activate a relevant mental model (activation principle) and then are shown an example of the problem they will learn to solve and how to solve this problem, they are more likely to see the relevance of each individual component skill when it is taught, and they will have a framework into which they can incorporate this new skill, greatly increasing the probability of efficient retrieval and application when they are confronted with a new instance of the problem.

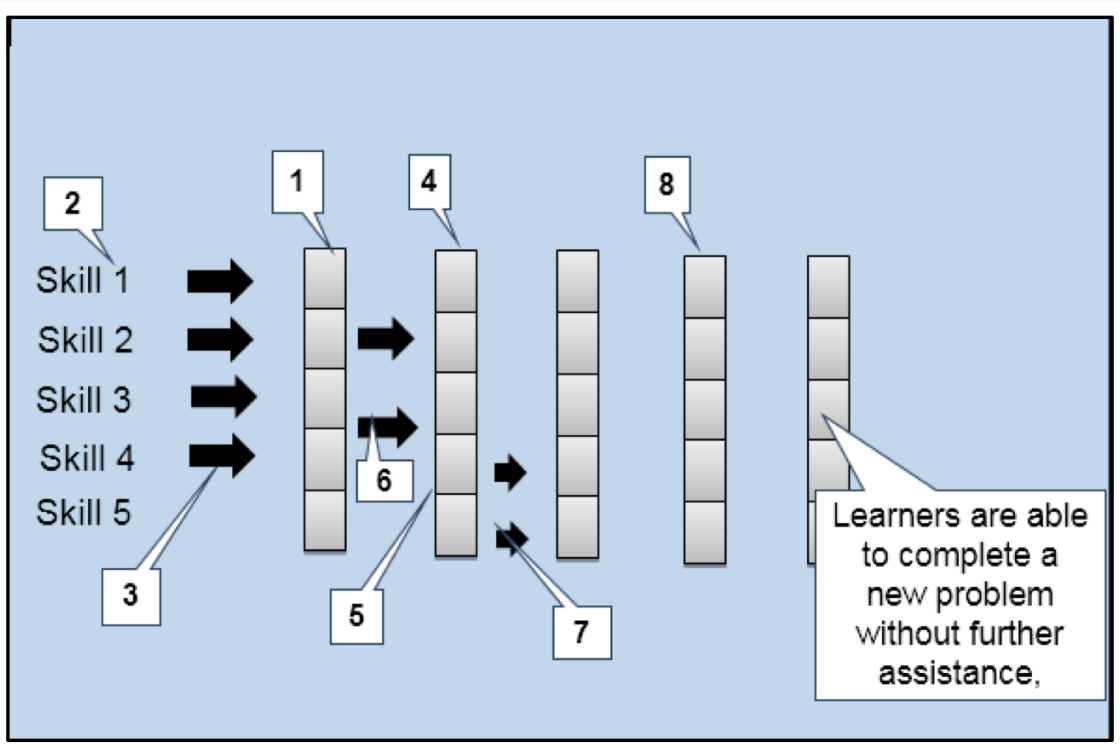

Figure 2. Problem-Centered Instructional Sequence

Does existing instruction use a problem-centered sequence in instruction? Even though many MOOCs are designed to facilitate problem solving, Margaryan and her colleagues found that only 8 of the 76 MOOCs they analyzed were problem-centered. Several previous surveys of existing instruction in a variety of contexts found that most courses do not use a problem-centered instructional sequence or even involve students in the solution of real-world problems as a final project.

A typical instructional sequence is topic-centered; that is, each topic is taught one-by-one, and then at the end of the module or course learners are expected to apply each of these topics in the solution of a final problem or the completion of a final task. Figure 2 illustrates a problem-centered sequence that turns this sequence around. Rather than telling an objective for the module, which is a form of information, the (1) first learning activity is to show a whole instance of the problem that learners are being taught to solve. This demonstration also provides an overview of the solution to the problem or the execution of the task. (2) Students are then told information about the component skills necessary for the solution of this instance of the problem and (3) shown how each of these component skills contributes to the solution of the problem. (4) After this *Tell–Show* demonstration for the first instance of the problem is complete, a second problem instance is identified and shown

to learners. (5) The learner is then required to apply the previously acquired component skills to this second problem (*Do*). (6) Some of the component skills may require some additional information or a different way of using the skill to solve this second instance of the problem. Learners are then told this new information and (7) shown its application to another instance of the problem. Note that the *Tell-Show-Do* for each component skill or topic is now distributed across different instances of the problem. The first instance of the problem was primarily *Tell-Show*. The second instance of the problem is a combination of *Tell-Show* for new parts of each component skill and *Do* for those component skills already acquired. (8) Additional instances of the problem are identified. Learners apply those skills already acquired (*Tell-Show*) and apply those skills already acquired (*Do*) for each new instance of the problem. The sequence is complete when learners are required to solve a new instance of the problem without additional guidance.

In a problem-centered instructional sequence learners are more likely to see the relevance of each new component skill. This sequence will provide multiple opportunities for learners to apply these newly acquired component skills in the context of real instances of the problem. It enables learners to see the relationship among the individual component skills in the context of each new instance of the problem. It also provides gradually diminishing guidance to learners until they are able to solve a new instance of the problem with little guidance.

Instruction that is revised to include a *Tell-Show-Do* sequence of learning events all in the context of solving a progression of instances of a whole problem or a whole task has the potential ofmaximally engaging students while providing efficient and effective learning activities.

Recommendation

In summary: Designers may want to analyze their courses. Perhaps the effectiveness, efficiency, and especially the engagement of a course may be enhanced by adding appropriate demonstration and application and by using a problem-centered instructional sequence. Does the course include appropriate and adequate demonstration? Does it include appropriate and adequate application? Are the skills taught in the context of an increasingly complex progression of instances of the problem?

Conclusion

Motivation is an outcome, not a cause. What promotes engagement and hence motivation? Effective, efficient, and engaging instruction. What promotes effective, efficient, and engaging instruction? First Principles of Instruction: Activation, Demonstration, Application, Integration, and Problem-centered. In this paper we have emphasized the demonstration and application principle and a problem-centered instructional sequence.

First Principles of Instruction is available in English in both print and electronic formats. It is also available in Korean, and Chinese.

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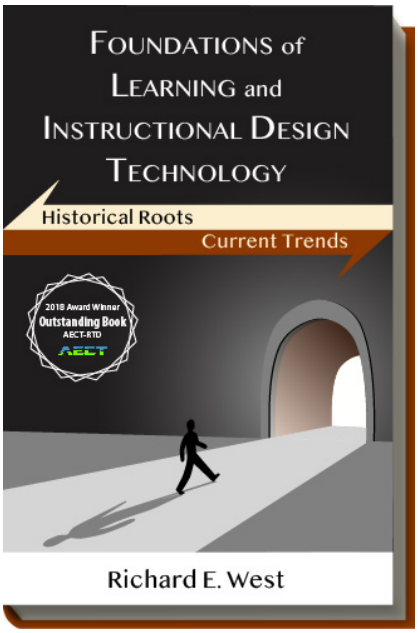
M. David Merrill

Dr. M. David Merrill is an instructional effectiveness consultant and emeritus professor at Utah State University. He has previously been a faculty member at George Peabody College, Brigham Young University-Provo, Stanford University, the University of Southern California, Utah State University, Brigham Young University-Hawaii, and Florida State University. Dr. Merrill has made major contributions to the field of instructional technology, including his development of the component display theory, elaboration theory, and instructional transaction theory. He has also published many books and articles in the field. He received his PhD from the University of Illinois.



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