Establishing Conditions for Learning From Online Training Curricula

By

Dr. Richard H. Vranesh

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Abstract

Purpose

For traditional instructor-led classroom presentations, the designer can ensure that the learner makes a connection to new factual type of material by becoming familiar with the prerequisite knowledge that is required to understand the instructional presentation and adjusting the level of the presentation and the examples provided during the presentation based on student feedback. Content organization and practical examples that enhance the online learning experience of new tasks and procedures and tie new procedures and job-tasks to old ones, however, create more of a challenge. The challenge is to avoid the creation of what is called "functional fixedness" which occurs as a result of becoming focused on a single task structure rather than its application to a wide variety of situations. It also is a product of the difficulty of providing a logical sequence for exercises and relevant examples that provide learning experiences that are sufficiently linked so as to be integrated with previous tasks and skills.

This paper examines how we can assist learners in to integrate new concepts and procedures to the level where they can be applied to similar by making them active participants in the instructional presentation and providing them with useful examples and tools by which to integrate new concepts and procedures with the existing knowledge base.

It also establishes conditions to ensure that the learner receives meaningful learning regardless of the current knowledge or experience with the new system. They include:

- The instructional product must make the learner an active participant in the learning process. This follows principles of Wittrock's Generative Learning Theory.
- The external requirements of the instruction must match the internal conditions of the learning. This is similar to Gagne's Conditions for Learning.
- The instructional exercises must be structured in such a way as to stimulate cognitive activity.

I. Introduction

Because new equipment is very gradually introduced in the field in the Federal Aviation Administration, by the time it becomes operational and technicians and operators can use it, there is often a large gap between when they receive new systems training and when they can apply it on a "live" system.

The Federal Aviation Administration (FAA) is seeking ways to design training that can be used for both novices and experienced personnel who understand the equipment but have not had very much time using it, and thus integrating new tasks and skills learned. FAA unions for both air traffic controllers and equipment maintenance technicians do not allow more than 30 days between initial training and equipment use or maintenance before "refresher" or remedial training is mandated to ensure that their personnel remain current.

The Agency is hoping to find ways to ensure that all trainees are trained to the same baseline level before they work or operate new equipment. Special additional classes purchased from a vendor cause the Agency to absorb a considerable additional burden on the new equipment-training budget and the cost of fielding new systems.

Audience

The intended audience of this paper is composed of instructional designers and curriculum developers who are required to develop new equipment training that can also be used to assist learners in need of overview material to refresh their knowledge of system operation and maintenance procedures. It also intends to benefit course designers who wish to create a hierarchical relationship with courses in their curricula that build on knowledge from basic beginner modules to more advanced concept courses. It is designed to provide assistance and guidance in tying together new experiences, examples, and procedures.

II. Methodology

To attempt to ensure that the presentation method complement the perceived relationship between the material and the existing knowledge base of the learner, methods of designing and presenting the learning material are provided that allow choices for the learner to make regarding (1) organization of the learning material, (2) activities that assist learners convert "comprehended information" into "learned information," through use of analogies or procedures, and (3) tools the learner can use to apply newly learned material in novel situations heuristics or algorithms.

Methods of determining preferred learning style, the type of knowledge needed by the learner, and tools they need to apply that knowledge are provided along with guidelines for designing the material and presenting it in response to these preferences.

A. Applications

The significance of letting the learner's knowledge level drive the content organization, type of activities, and strategies that are provided to apply the new knowledge relate to how the instructional designer can stimulate the thinking of the learner to make inferences from what they know to what they are seeking to learn.

Thinking leads to modification of the learner's internal representation of a plan in memory by restructuring subgoals so that they are viewed in terms of a criterion performance. This view provides a structure to the method by which the knowledge is accessed and applied to novel situations. The results of this modification, then, are comprehension. Comprehension leads to an understanding of the relationship of the fundamental concepts to be learned.

III. Summary

The significance of trying to accommodate learner preferences and meet conditions that have been successful for distance learning is that if skills for comprehending, integrating, and applying new knowledge can be taught while the learner is acquiring it, the learner can come away from learning with a plan for decomposing the information and reconstructing it to apply in similar situations. What is especially gratifying for those of us who work extensively with distance learning curricula is that we are assured that the learner is very actively engaged in constructing an abstract representation of the knowledge so that it can treat future problem instances or concepts as members of the same class.

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Presentation

Introduction

Unlike instructor-led classroom teaching, online learning programs rely heavily on their design to convey their instructional intent and ensure their instructional outcome. There is no live interaction, modification, or tailoring of the message to meet the needs of the learner. Thus, it cannot be modified to fit the knowledge or skill level of the learner. Rather, their purpose has already been predetermined in the tasks analysis phase of the instructional design. The content of the program is then based on the tasks and skills to be learned and knowledge of the prerequisites that have been determined to be a prelude to understanding the content of the course. Since the instruction has been custom-built for students that have the prerequisites to learn the new material, the designer assumes that it will be assimilated into the existing knowledge structure about the domain.

It can be argued that there is an innate tendency in our brains to connect and interpret new information with that which has been learned and practiced on a regular basis. Thus, we assume that learner's construct higher-order interpretations of phenomena by integrating new information with old knowledge. This paper questions, however, whether the same process occurs for experiences. Are new experiences automatically connected with those that we have encountered in the past? For instructional content, the designer can ensure that the learner makes a connection to the new material by determining which prior knowledge will be relevant and which strategies will be useful in approaching the new text. Practical exercises to tie new procedures and job-tasks to old ones, however, create more of a challenge. The challenge is to avoid the creation of what is called "functional fixedness" which occurs as a result of becoming focused on a single task structure rather than its application to a wide variety of situations. It also is a product of the difficulty of creating lab exercises that provide experiences that are sufficiently linked so as to be integrated with previous tasks and skills. For learning experiences to be meaningful, they must move the learner from a state of cognitive awareness to felt meaning.

Tomlinson (1999) [1] states that the brain is physiologically predisposed to connect parts to wholes. In other words, the brain seeks meaningful patterns while resisting meaningless ones. Therefore, successful learning activities should provide students a chance to have a novel cognitive experience that permits such a connection to be made. If we want students to benefit from our instructional presentation without the benefit of observing them directly, we need to identify and incorporate such activities that will assist in making this connection and incorporate this into our design.

Johannsen et al (1999) [2] indicates that the more directly and interactively we experience things, the more likely we are to construct new knowledge. To provide meaningful experiences, then, the student must be an active participant in building this connection. But how can we be assured that students will make such a connection if they are not physically present to guide our design?

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[1] Tomlinson, C.A. (1999). The differentiated classroom: Responding to the needs of all learners. Virginia: Association for Supervision and Curriculum Development.

[2] Johannsen, D.H., Peck, K.L., & Wilson, B.G. (1999). Learning with Technology: A constructivist perspective, Upper Saddle River, N.J.: Merrill Publishing.

The most often used instructional design model is based on a systems approach to learning that begins with the analysis of desired learning tasks. This approach is guided by a hierarchical model of the tasks to be trained and sequences instruction in consort with this model. Thus, a progression of knowledge is developed beginning with elicitation of simple discrimination skills, followed by basic concept development, rule learning, and ultimately terminating with the presentation of problem-solving strategies. This design is based on Gagne's (1985) [3] learning outcomes. Inherent in this design is a fixed sequence of tasks that are linked in order of their importance to performing a specific duty. This sequence is predetermined based on the relationship of tasks to each other and their level of difficulty and complexity. The resulting structure although inherently logical may not provide instruction in the most useful and meaningful sequence to the learner however.

According to Reigeluth (1996) [4], instructional designs should allow learners to make decisions about both content and strategy while instruction is in progress not in a predetermined fashion. Distance learning designs can and should incorporate this feature because it is based on adapting the learning to the needs and the most convenient situations for learning. The importance of involving the student in developing adaptive instruction is that it allows the student to actively decompose the task structure and discover first-hand that there is not just one magically right structure for presentation of the task and, most importantly, for task performance. Thus, the tendency toward "functional fixedness" on the task is avoided during initial learning and does not have to be corrected by repetitive task practice during proficiency training. If the learner is actively involved in shaping the sequence of instruction, then the order of presentation will match not the assumed but the implicit knowledge structure of the student.

The major shift in the traditional paradigm of Instructional Systems Design is that the analysis is not done for a whole batch of learners by the designer ahead of the instructional situation, but rather; is done for an individual learner or a small team of learners during instruction. This approach, however, requires that designers provide content in an array of different presentation formats that provide the learner with the choice of what to learn next and how to learn it.

Learner-Focused instructional theory offers guidelines for the design of learning environments that provide appropriate combinations of challenge and guidance, empowerment and support, self-direction and structure. To provide learners the opportunity to shape the learning environment, they must be able to make decisions about the instructional methods that are used to provide it. Since most learners are unfamiliar with the vast array of effective instructional approaches that are used today to design instruction, students should be allowed to choose from among sound alternative approaches that are structured to help integrate the new content.

Banathy (1991)[5] recommends that learners have the capability to request the computer system to use some different instructional strategies as well as it determines the most effective ones based on learner input. Thus the gap is bridged between what the designer perceives to be the best presentation method and order of the material to what works best for the learner.

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[3] Gagne, R. (1985). *The Conditions of Learning (4th ed.)*. New York: Holt, Rinehart & Winston.

[4] Reigeluth, C. M. (1996). A new paradigm of ISD? Educational Technology, 36(3), 13-20.

[5] Banathy, B (1991) , *Systems Design of Education: A Journey to Create the Future* Educational Technology Publications, Englewood Cliffs, NJ, 1991)

Conditions

To ensure that instruction fosters this type of meaningful learning, three major conditions for distance learning programs should be present. According to Grabowski (1997) [6], they are:

- The instructional product must make the learner an active participant in the learning process. This follows principles of Wittrock's Generative Learning Theory.
- The external requirements of the instruction must match the internal conditions of the learning. This is similar to Gagne's Conditions for Learning.
- The instructional exercises must be structured in such a way as to stimulate cognitive activity.

To meet the first condition, we make the learner an active participant by consciously choosing the method the relationship between new and prior information is linked. The form of this relationship depends on the method by which it is taught and elaborated on. The presentation method should complement the perceived relationship between the material and the existing knowledge base of the learner thereby increasing the relationship between new information and prior knowledge. In most conditions, the new material is a subset of a general concept that the leaner knows (forming a part to whole relationship) or it presents a new concept of which the learner has knowledge of a smaller subset (a part to whole relationship). By permitting the student to learn by either method (based on questioning the learners as to how they perceive the ordinate/subordinate relationship), we are organizing the material for the learner in a meaningful way. The way that this is reflected in the teaching presentation is either inductive through examples that lead to determination of rules or deductive from rules for which students determine or create proper examples.
By clearly presenting the material in the same form that it is related in the existing domain knowledge, the new information is learned in a manner that it can be easily assimilated into existing domain schema.

This leads to another important requirement for developing instruction that will be presented without the physical presence of a developer or instructor—a model of how the learning system is to operate or a cognitive map of how the new learning is to occur. To ensure that external requirements of the instruction must match the internal conditions of the learning, we construct a model of the learning environment based on making connections between new and existing information, the use of elaboration strategies to strengthen this connection, and stimulation of cognitive activity through using heuristics and algorithms to provide learners with a useful strategies for learning the material.

In her review of cognitive learning theory, Derry (1990)[7] provides the following cognitive model for learning meaningful information (Shown as Figure 1 below)

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[6] Grabowski, Barbara L. "Mathemagenic and Generative Learning Theory: A Comparison and Implications for Designers". In, **Instructional Development Paradigms**. New Jersey: Educational Technology Publications, 1997.

[7] Sharon J. Derry, "Learning Strategies for Acquiring Useful Knowledge. In Dimensions of thinking and cognitive instruction, ed. Beau Jones & Lorna Idol (Hillsdale, NJ: Erlbaum, 1990), p. 347 - 379.

Figure 1 – Cognitive Model for Meaningful Learning

In this model, new information is (1) connected to prior knowledge (2) in working memory (3) through establishing a connection via a presentation method that takes this relationship into account (whole to part or part to whole presentation method) and elaborates (4) on the relationship as part of the content of instruction. This model serves as a blueprint for components of a successful online learning program. At each major instructional event, we provide assistance to the learner to ensure that the outcomes that we are hoping to achieve in the model do occur as predicted.

For example, once new information has been comprehended--by linking it to what is already known--cognitive theorists say that the new information can then be learned through activities which enrich the connections between the new and the old knowledge. Researchers have studied some ways students convert "comprehended information" into "learned information," through such activities as taking notes, summarizing, outlining, making analogies, relating the information to yourself personally, creating mental imagery, and similar activities known as elaboration. Through use of analogies or procedures, we can assist the learner in enriching the connection between the new and old knowledge.

Additionally, to ensure the applicability of this knowledge to related domains not specifically learned in a customized learning environment, we can provide heuristics or algorithms for the learner to apply to new learning situations as strategies for assimilating the new material and applying what they have already learned. Through providing tools to the learner to assimilate new information into existing schema, we are helping the learner convert "comprehended information" into "learned information." The knowledge learned can then be labeled “meaningful” because it is richly connected with related knowledge. It is also “useful” because it contains means of cross-referencing and accessing other knowledge to which it is connected.

Learning takes place when the new information becomes a part of the existing knowledge network. . The new knowledge can fit into the existing knowledge network or it can modify that network. When elaborated and richly integrated, the new knowledge becomes meaningful and useful.

In summary, programmed learning packages need to contain conditions for learning to take place, for it to be related to existing knowledge (the number one team won again) so that it can be modified or to modify the existing network of knowledge (the number one team moved to another state), and for it to become meaningful and useful.

IV. Methodology

To attempt to ensure that the presentation method complement the perceived relationship between the material and the existing knowledge base of the learner, the learning material should be designed with choices for the learner to make regarding (1) organization of the learning material, (2) activities that assist learners convert "comprehended information" into "learned information," through use of analogies or procedures, and (3) tools the learner can use to apply newly learned material in novel situations heuristics or algorithms.

When learners are exposed to new material, however, they are not familiar enough with the outcomes and objectives of the instruction to indicate a logical preference for one organization over another or certain types of scenarios. Therefore, we use leaner feedback in response to on-line questions about content relationships in order to ascertain their level of knowledge of the conceptual relationships embedded in the design of the instruction.

The significance of letting the learner's knowledge level drive the content organization, type of activities, and strategies that are provided to apply the new knowledge relate to how the instructional designer can stimulate the thinking of the learner to make inferences from what they know to what they are seeking to learn. Thinking leads to modification of the learner's internal representation of a plan in memory by restructuring subgoals so that they are viewed in terms of a criterion performance. This view provides a structure to the method by which the knowledge is accessed and applied to novel situations. The results of this modification, then, are comprehension. Comprehension leads to an understanding of the relationship of the fundamental concepts to be learned.

A. Learning Material Organization

The first choice that the learner would make in adapting the material to his/her level of learning is the organization of the material. Brown (1984)[8] investigated various approaches for teaching musical keyboarding. In an approach for novices, subjects began by learning sequences of keys and notes in the same musical octave working up to the entire keyboard. He then began teaching those familiar with reading music the entire keyboard then breaking it down into different musical octaves. Although the more advanced group learned faster, the novices made fewer errors, until eventually both reached criterion without errors at about the same time. Knowledge integration in Brown's and various other studies by Sawdon, Crofts, etc. show that matching the learning to the integration level of the learner causes both types of learners to achieve mastery levels at the time predicted based on their level of experience with the skills and knowledge to be learned.

[8] Brown, R.W. (1984) Whole and Part Methods in Learning. Journal of Educational Psychology, 1984, 25, 1, 229-33.

Questions that would tend to indicate the better fit for the leaner would be questions about isolated facts for the part to whole method versus questions about concepts and relationships for the whole to part method. In response to the answers provided, the deductive (proceeding from rules to examples) or inductive (beginning with simple examples and encouraging the learner to determine the governing rules) is provided.

For example, suppose you are teaching instructional designers how to write three-part instructional objectives. Before beginning a lesson, you first wish to determine the depth of their knowledge base about the topic. Since most designers have been teachers sometime in their career, there will a wide divergence on knowledge and experience of learning objectives. To determine the depth of knowledge about how to write objectives for your target audience, you can ask what is the purpose of instructional objectives (to determine their knowledge of the concept). Those who demonstrate a good understanding of the concept could then proceed with writing objectives for achievement of a specific task. Those who do not indicate a firm grasp of the concept of objectives may benefit from working with more examples. For this group, you could list several objectives and ask what the students sees that they have in common (to test their knowledge of specifics). Those who can point out the parts of the objective as those elements that all of the examples have in common, could then proceed with expanding the conditions, behavior, or standards until they can create their own objectives. You have thus reached the same level of learning by teaching two different groups the same content in different form but at their level of knowledge, their preferred method of operation (working with concepts vs examples), and by capitalizing on what they know and are currently proficient in doing.

In our model, we have the made the connection between the new information and that which has previously been learned. In our example, the new knowledge about the purpose and structure of objectives was (1) connected to prior knowledge about teaching and learning (2) in working memory (3) through establishing a connection via a presentation method that takes this relationship into account (whole to part or part to whole presentation method) and elaborates.

The next step in the model involves strengthening this connection in working memory through elaboration.

B. Learning Material Integration

Studies of teaching relationships through either conceptual diagrams (Venn diagrams), using Baysian set relationship drawings or, for teaching machine operations through flow diagrams showing input and output are often compared with simply teaching procedures without ensruing conceptual understanding. Both types of instruction have been shown to work better with various learning styles. Greeno (1975-1979) has extensively studied teaching procedures and analogous relationships between concepts in developing a strategic plan for problem solving.

His findings tend to indicate a trend for matching a specific type of presentation method to learner preference to enhance performance. To determine user preference for analogies or procedures, simple problems could be provided with both a drawing and procedures for solving the problem and asking which tool the learner would prefer to have while trying to solve or fix the problem.

In teaching prospective designers, for example, we could teach task analysis by using a flow diagram or a textual outline of jobs, duties, tasks, and steps. For the simple task of sharpening a pencil for instance, we could teach how to diagram the tasks as follows:
Another way to teach analyzing this task is asking the student to outline the task by listing the job, duty, task, and steps, as follows:

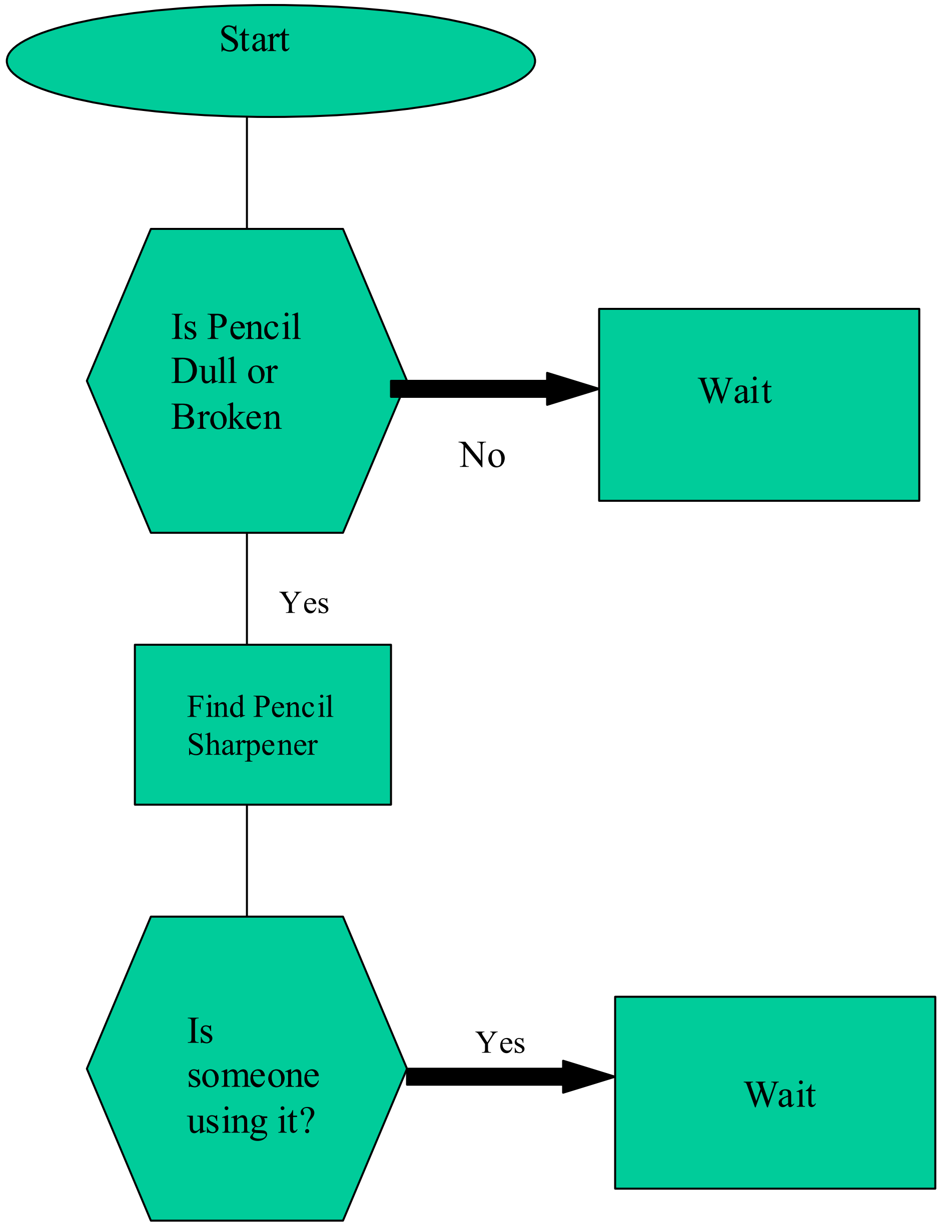

Figure 2 – Task Analysis of Pencil Sharpening

The same task could be diagrammed as follows:

I. Job—Maintain Classroom Tools and Equipment

A. Duty—Sharpen Pencil

1. Tasks

a) Ensure Pencil is Dull

b) Ensure Sharpener is not in use

Either method is effective, but it has been found by Davidson (1976)[9] that many leaners had improvements in comprehension by using Venn diagrams to analyze information.

C Transfer of Learning Tools

Heuristics and algorithms are both tools that can be used to apply new knowledge in novel situations. The relevance of which to use determines what tool best helps to activate the learner's application plan. The answer depends somewhat on what criterion performance is expected to be. If use of a specific algorithm is sufficient to solve a particular type of problem then teaching the algorithm is sufficient. However, if problems are going to be taught requiring a broader understanding of concepts, then the type of performance expected of the learner should shape the tools that are given for application of the knowledge. To arrive at which module to provide—that using heuristics or algorithms—then can be determined by asking questions about why the student is taking the course or training to begin with. Based on the online response, either a heuristic for solving a class of problems or an algorithm for solving a specific problem is provided.

Heuristics and algorithms provide elaboration to ensure that the new material becomes imbedded in the existing cognitive network.

In our example of teaching instructional designers, the topic of transfer of training is an important component of an instructional design. A basic assumption underlying all training is that it will transfer from one situation to some other situation (called the referent situation). To ensure this occurs, we can be cognizant of several guidelines or heuristics such as "Try to include as many elements from the real-life situation in the training condition as possible." This principle could also be incorporated in an algorithm that evaluates the transfer situation. These data can be collected by evaluating test performance and assigning numbers asking students to assign numbers to correct answers to attempt to construct the proper sequence of knowledge leading to maximum transfer.

Both can be provided to the student and the student can be asked to develop a lesson based on whichever transfer of training methodology that the student wishes to use.

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[9] Davidson, R.E., The role of metaphors and analogy in children's thinking. In J.R. Levin & V.L. Allen (Eds.) Cognitive learning in children's theorems and strategies. New York: Academic Press, 1976, 135-162.

Summary

The significance of trying to accommodate learner preferences and meet conditions that have been successful for distance learning is that if skills for comprehending, integrating, and applying new knowledge can be taught while the learner is acquiring it, the learner can come away from learning with a plan for decomposing the information and reconstructing it to apply in similar situations. What is especially gratifying for those of us who work extensively with distance learning is that we are assured that the learner is very actively engaged in constructing an abstract representation of the knowledge so that it can treat future problem instances or concepts as members of the same class.

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About the Author

Dr. Richard Vranesh is a Senior Principal Engineer for Affiliated Computer Services, Inc, an engineering integration and outsourcing firm. At ACS, Dr. Vranesh assists the Federal Aviation Administration (FAA) in developing effective designs for training, curriculum planning for Air Traffic Controllers and equipment technicians, and research into effective instructional presentation methods.

He is currently the president of the Washington, D.C. chapter of the Association of Educational Technology (AECT) and an author and frequent contributor to the Society for Applied Learning Technology.