Guidelines for Writing More Exact Specifications for Acquisition of E-Learning Training Programs for Advanced Cognitive Skills

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Introduction

Training programs for new systems are usually developed jointly by the system developer and the customer. The customer provides a list of the job categories in the workforce that need to be trained and the system developer, either solely or jointly with a training subcontractor teaches each job position what part of system operation or maintenance that they need to know to be able to use the new system on the job. Specifications for the educational products are provided by the customer in the contract's Statement of Work and are further defined in the documents required by the contract.

The specifications in the contract are often very general in nature and do not always result in the acquisition of the intended product. This happens because the design documents usually describe only the components of a training program and do not specify a strategy or an approach to ensuring the success of the training. What is usually not specified in these includes the outcomes of the instruction, the underlining theory on which the training program is constructed, and specifications on how the training program is to achieve the outcomes.

For teaching relatively basic skills and knowledge, shot lists, storyboards, detailed screen design specification, scripts, or scenario descriptions will suffice to transmit the intent of the product to the system developer. However, when acquiring programs that require higher levels of cognition and are intended to teach more complex problem-solving skills, a common understanding between the customer and the developer is required. At this level, the specifications often determine the program design because no direct feedback is gleaned from the target audience and other designs cannot be tested out on the sample population. To ensure that program outcomes are met by the e-training product, specifications are required that indicate the how the student is to learn from training program, how the program will teach the required knowledge and skills, and what learning theory has been proven to be successful in meeting program objectives

Outcomes of instruction must be specified so that there is a value indicator by which to evaluate program success. Finally, a strategy for designing the training program is essential because it indicates how the program has been customized to the type of learning to be presented, the knowledge level of the learner, and the learner's job requirements.

If we can assume that a training program has been developed to address an instructional problem, which is a rather routine reason for developing training, then the application of a solution to this problem should then be accomplished by the manipulation of elements of the learning environment that have been identified as causes of the problem. How these variables are to be manipulated should then form the architecture for the various instructional components that comprise it. This architecture becomes the design of the instruction and the resultant configuration of components the instructional strategy for the solution of the problem. The purpose of this paper is to provide guidelines for developing instructional designs that are readily apprehended by the customer, based on proven applications of learning theory, and lead to a clear instructional strategy that is traceable and to the outcomes of instruction.

Purpose

The reason that these designs are particularly applicable for development of e-learning specifications is due to the difficulty and cost involved of changing the design once e-learning products have been developed and delivered on schedule. Additionally, since the products are used in a distance environment, the type of feedback that can be gained in a classroom presentation can not be obtained to make program refinements.

The framework for making instructional design decisions is the **learning strategy**. The learning strategy, according to Wittrock (1992) [1], is a person's approach to a learning task. Since the end of the instruction is to develop skill and facility in task performance, the learning strategy provides an outline for course design. Design components are developed to follow the learning strategy and decisions that are made during the design involving competing choices are guided by learning theory.

The result is a schematic for lesson design and instructional sequence. If this key component of instructional theory can be customized to ensure that the instruction provided fits the needs of the learner, then the acceptance for the program should be guaranteed and maximum utility made of the program provided.

Methodology

Using Wittrock's definition--a person's approach to a learning task—it is easy to see how important a learning strategy is to building a training program. The learning strategy indicates how a person thinks and acts when planning, executing, and evaluating performance of a task and its outcomes.

Instruction on using learning strategies can assist the learner in obtaining more benefits from instruction as well. According to Merrill (1997) [2], learning strategy instruction focuses on making the student a more active learner by teaching students how to learn and how to effectively use what has been learned.

A learning strategy is a useful tool in making informed design decisions and ensuring user acceptance of the instructional product. Development of a learning strategy is accomplished by including elements of instruction that are meaningful to the learner.

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[1] Wittrock, M.C. (1992). Knowledge acquisition and comprehension. In M.C. Alkin (Ed.), Encyclopedia of educational research (6th ed., pp. 699-705). New York: Macmillan.

[2] M. David Merrill, Instructional Strategies that Teach, CBT Solutions Nov./Dec. 1997 1-11.

Thus, we are assured that meaningful learning will take place. According to Grabowski (1997)[3], three conditions must be present for learning to be meaningful. These are:

- The instructional product must make the learner an active participant in the learning process.
- The external requirements of instruction must match the internal conditions of the 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 teaching method that matches the relationship we believe that the learner between the new information to be learned and that which he/she already knows. The form of this relationship determines the method by which it is taught and further elaborated on. The presentation method should complement this perceived relationship between the material and the existing knowledge base of the learner thereby increasing the relationship between new information and prior knowledge.

For most new training programs for new systems training, 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). 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.

The elements of the learning strategy diagram the learning process for us. If we define learning as the process of acquiring meaning form the potential meanings in the learning material, then meaningful learning requires not only acquiring the intended learning outcomes but also retaining them in an easily retrievable manner. Retention, then, is the process of maintaining the availability of a replica of new meaning. From these definitions, we have the essential elements of a learning strategy—A method of elaborating on the meaning of the learning material so that it can be retained by the learner in the most efficient and effective manner possible.

Before any instructional decisions are made, a map of how learning is to occur in our system should be devised. In the same manner as a schematic diagram must be approved before any building is started or development is begun on a new system, a diagram should be made of how our learning system works. To ensure that external requirements of the instruction matches the internal conditions of the learning, we construct a model of the learning environment based on making connections between new and existing information. The model should seek to show how 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

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

knowledge becomes meaningful and useful This leads to another important requirement for developing instruction—the model of how the learning system is to operate or a cognitive map of how the new learning is to occur. Our learning strategy, then, needs to specify 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.

Procedure

If we were to diagram the conditions required for meaningful learning to take place, it would strongly resemble that developed by Derry (1990)[4] to depict the process of meaningful learning.

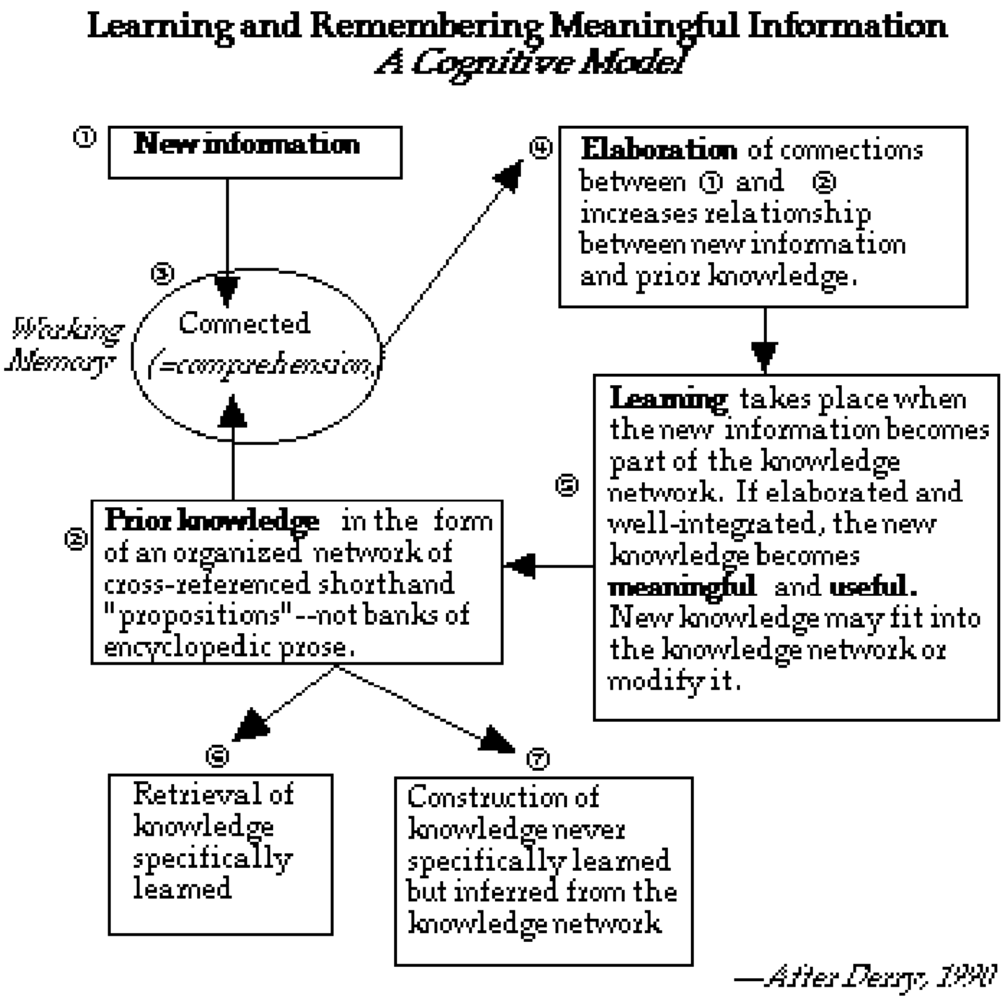

Figure 1—Meaningful Learning Model

[4] 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.

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 and elaborates (4) on the relationship as part of the content of instruction. This model serves as a blueprint for components of a successful meaningful learning program.

In development, the model serves as a structure for learning content so that all new content included in the design must be connected to prior knowledge via a method that takes into account the relationship as part of the presentation method. This structure then translates into the format and display of the training material as well as the sequence of the presentations.

To learn new features of an existing system, lesson plans would, for example, begin with a review and tie-in section, followed by an outline of the main points followed by elaborative data thereafter. Customization to the current training problem occurs when we build an instructional strategy that is based on and uses our learning strategy.

If the knowledge and skills is novel to the learner, then the training program should begin with a basic overview of the new system and a review of any prerequisite knowledge that is required to learn and use the new system. Learning of new concepts involves similar strategies by using familiar examples to derive new and more inclusive connections and rules defining their behavior. When we have incorporated these three conditions for meaningful learning into our training program, we have a learning strategy to apply to the learning content and skills that will be taught in our training program.

This paper presents a variety of instructional strategies and learning and teaching models for four different types of knowledge and skill learning to teach: They are:

- Factual knowledge
- Semantic knowledge
- Schematic knowledge
- Process knowledge

All models contain a methodology for connecting new information to prior knowledge (2) in working memory (3) through establishing a connection via a presentation method that takes this relationship into account and elaborates (4) on the relationship as part of the content of instruction. Thus, we will ensure the applicability and the success of our models by using all of the components that result in meaningful learning.

Results

<u>Factual Knowledge Strategy</u>

Factual knowledge is necessary for learning the parameters and dimensions of a domain of knowledge. A knowledge domain is what will be provided to the learner, and to what extent. This is where you define what the instruction will "cover" in your learning environment. You will need to define the starting points and the expected ending points.

To be able to build on the knowledge they have mastered, students need to be provided many opportunities to work on assignments to gather information from multiple sources including libraries, museums, and other community sources. Thus, a practice component needs to be part of the factual knowledge strategy to further develop the knowledge.

The learning system model for factual knowledge depends on the complexity of the knowledge to be learned. In situations where the learner needs to be able to transform the knowledge that is to be presented to fit the situation where it is to be used—as is often the case in knowledge proceduralization—application needs to be part of the instructional strategy. Factual knowledge is transformed into procedural knowledge by appropriate feedback and practice that involve coaching, error detection and correction, and by solving a sequence of slightly varied problems to prevent and type of functional fixedness.

Figure 2, below, depicts a learning model for learning factual knowledge to apply in a directed situation.

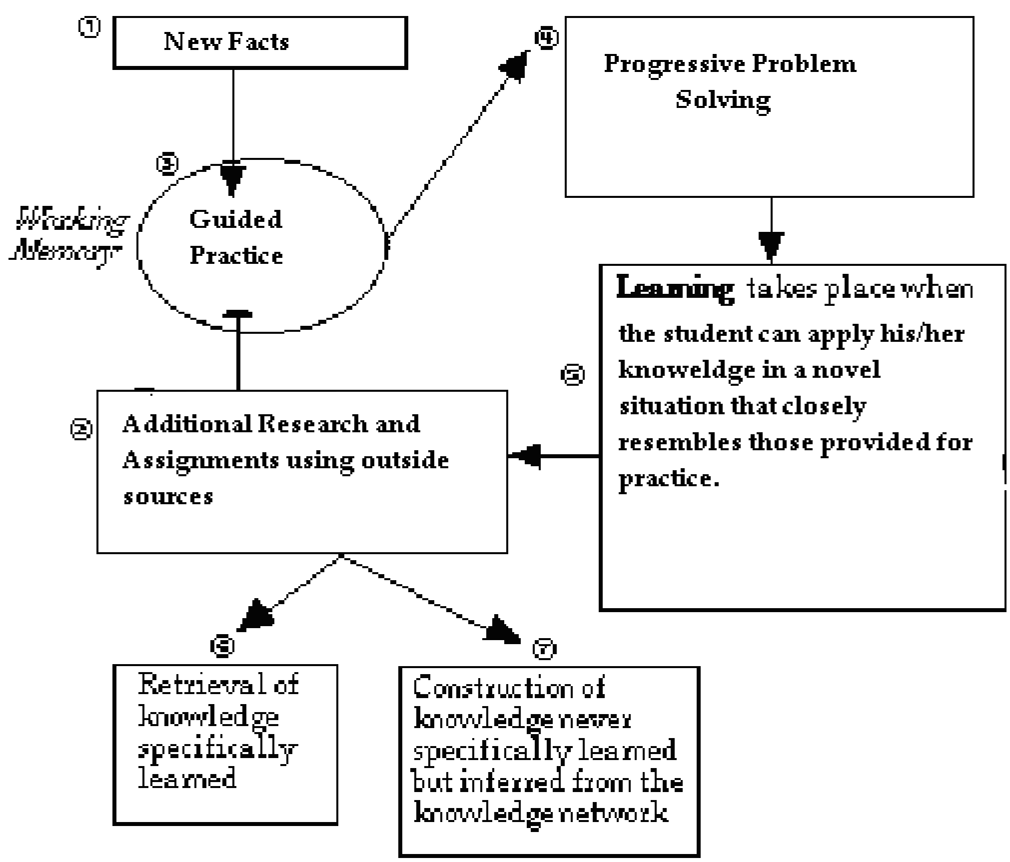

Figure 2—Factual Knowledge Learning Model

New facts are immediately built upon by conducting additional research. This knowledge is then integrated with what the student already knows by providing guided practice in progressively more diverse situations so that a strategy for acquiring related knowledge is learned and used in novel situations. Such a model could then be customized to the current situation by adding a feed back loop in the form of a lab or practice session and intermittently dispersed recall questions.

A currently well-used method of teaching factual knowledge is through hypermedia, such as streaming video and hypertext. Hypermedia Systems (HMS), which are based on hypertext, are non-sequential, non-linear methods of displaying text, graphics, sound, and video. They use interface design and advanced navigational tools, and assume that the student's interpretation is more meaningful that the expert's. Hypermedia Systems use a “constructivist approach to learning, where learning is regarded as the formation of "constructs" of understanding by the learner. The learner builds the knowledge based on previous understanding by interacting dynamically with the domain structure. HMS provides a suitable means for this approach because they allow the learner to take control. This system allows the learner to make an informed decision regarding where to proceed in the material. In the case of hypermedia learning, the teaching model and the learning model merge since the instruction is self-directed. A model that reflects the layers involved in hypermedia learning is depicted in figure 3 below.[5]

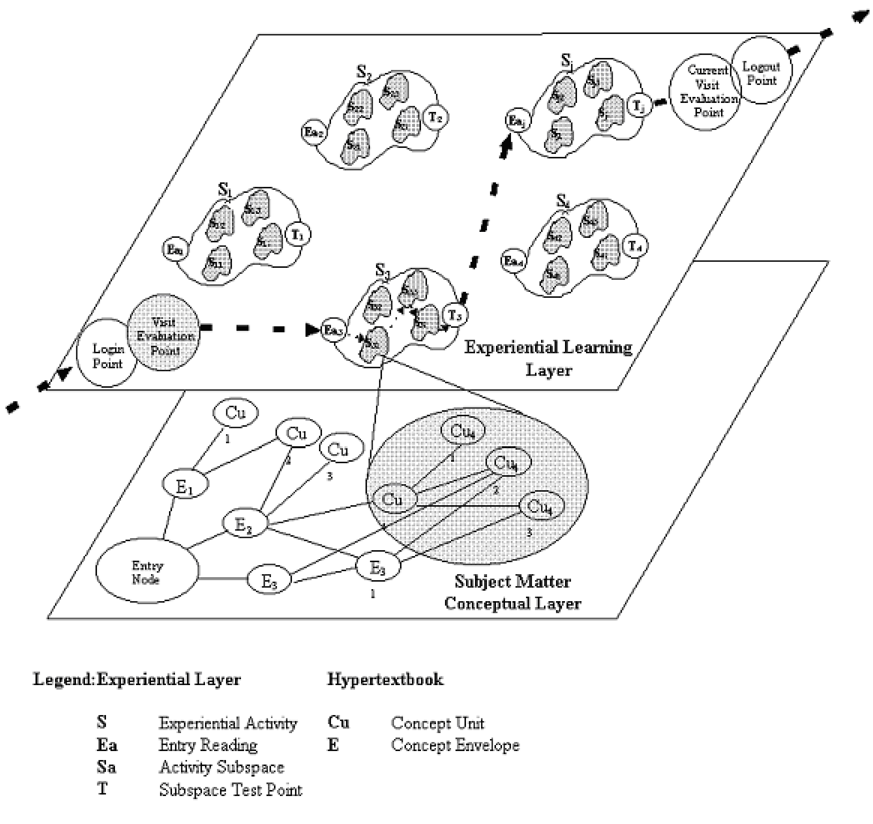

Figure 3-Hypermedia Learning Model

[5] José Miguel Baptista Nunes and Susan P. Fowell (1996) Hypermedia as an experiential learning tool: a theoretical model, *Information Research*, Vol. 2 No. 1.

Hypertext material is divided into layers of information. For each subject matter layer there is a conceptual layer. The Subject Matter Conceptual layer can be entered from any point in the experiential learning layer whenever the need for support on the subject matter arises. The conceptual layer likewise support the subject-content area when students wish to learn underlying theories or principles for the facts they have discovered. Thus, the learner can freely navigate until all problems on that particular concept are resolved.

Semantic Knowledge Strategy

Semantic knowledge is knowledge of concepts. Students generally discover concepts and connections between natural phenomena by actively determining which concepts account for or explain the relationship between similar events. Students can also be encouraged to perform open-ended activities that stimulate their curiosity, become familiar with the instructional materials, and formulate early understandings of tasks.

The model of learning that best promotes active learning of acquisition and utilization of concepts stipulates active learning through structured activities that provide opportunities to make their own discoveries and draw their own conclusions.

Figure 4 depicts a learning model for concepts and semantic knowledge.

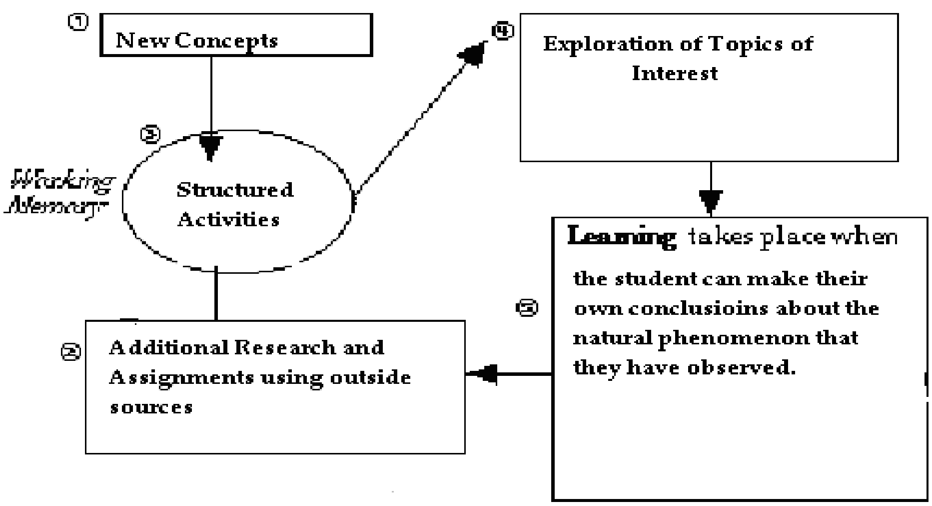

Figure 4—Conceptual Knowledge Learning Model
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Figure 5 depicts a learning model for concepts and semantic knowledge.

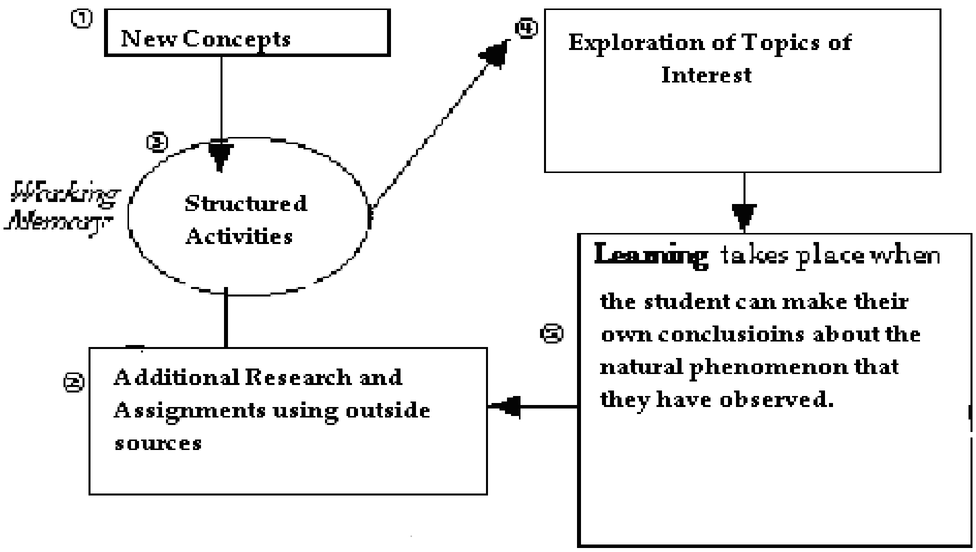

Figure 5—Conceptual Knowledge Learning Model

A distance learning environment for conceptual knowledge learning world be one that is rich in exploration and experimentation. Such exploration could be conducted through gaming or similar type of simulated learning programs that explore the natural world, literature, mathematical principles, or history. The exploration activities, however, would need guidance in the form of a written summary of the findings or the development, by the student, of a principle or concept that explains the events and phenomenon that he or she has observed.

For distance learning of semantic knowledge, then, the teaching model will resemble the following:

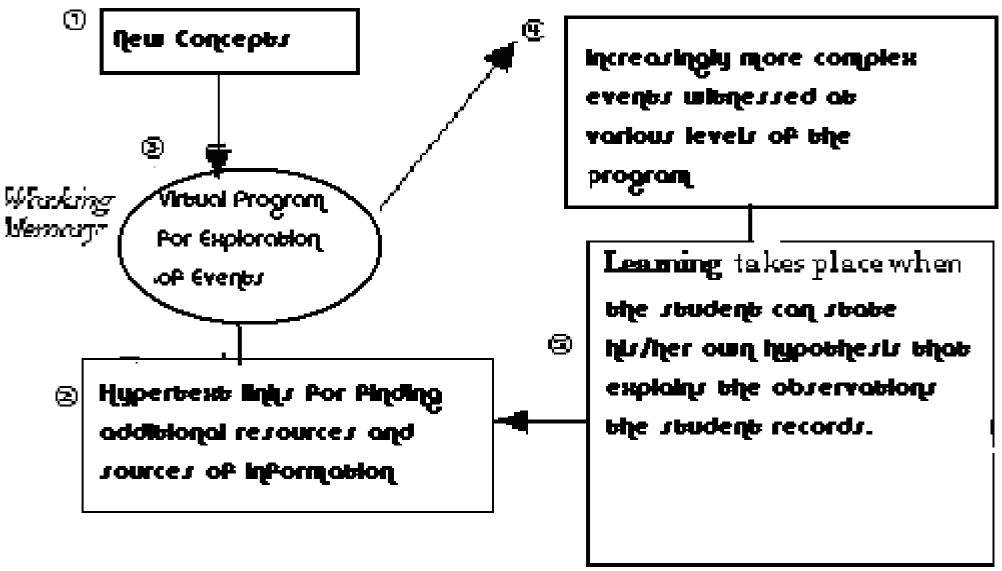

Figure 6—Conceptual Learning Distance Teaching Model

In this model, exploration is conducted in a virtual or quasi-virtual environment that allows the learner to try out different strategies and data gathering methods and receive immediate feedback on their results. Further, the elements of the events that the student is attempting to categorize are made more diverse yet similar in several respects, events that normally can not be find in the natural environment. These categorizations strengthen the understanding of the concepts and their applicability as well.

<u>Schematic Knowledge Strategy</u>

Schematic knowledge is the knowledge of knowing why something has happened. It is the next step in reasoning from arriving at a concept that explains the relationship of data in a category and calls for model building. The model is built from different theories about observations that explain how a process occurs. This explanation requires development of a prototype or ‘new” theory to the learner that can be tested and verified.

Shavelson, Li, Ruiz-Primo, & Cuahtemoc (2002)[6] provide an example of how a schematic knowledge model is built on observations from similar categories of data concepts. In their example, observations about the rotations of the planets are made and an explanation or model of how rotation occurs in the universe is requested to explain why daylight and darkness occur on earth at different times. The answer that "the earth revolves around the sun requires further elaboration and exercise of schematic knowledge. Figure 7, below, illustrates these features in an integrated fashion.

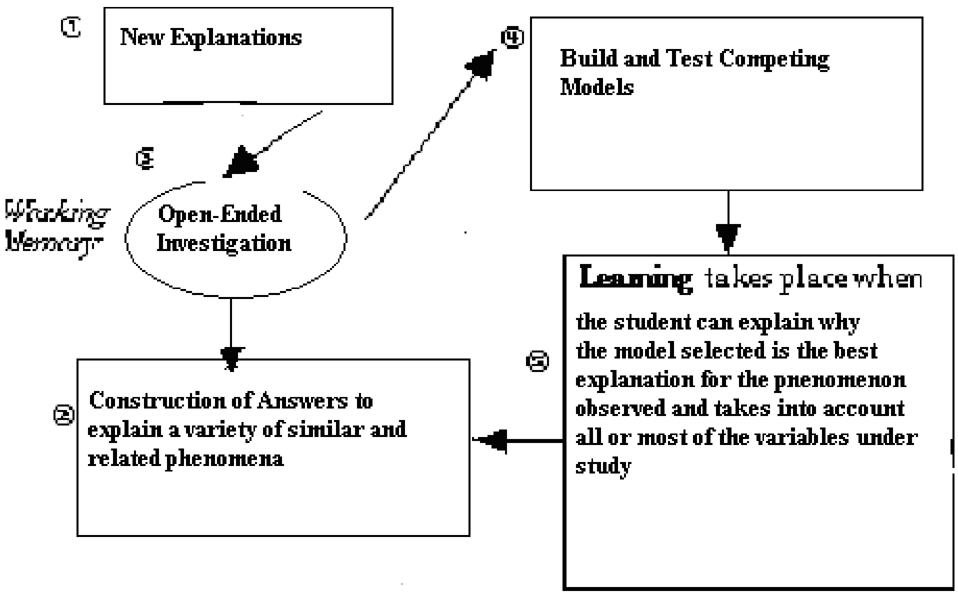

Figure 7—Schematic Learning Model

In this model, open-ended investigations are the key to learning new explanations and constructing answers to questions of why things work as they do. Building and testing models is a major component of t he model because it ensures that among a wide variety of competing explanations for the events observed, the chosen model takes into account the concepts and principles that have been learned in the area of investigation under study.

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[6] R.J. Shavelson, Min Li, Maria Ruiz-Primo, & Carlos Ayala (2002), *Keynote Address of the Joint Northumbria/EARLI Assessment Conference,* University of Northumbria at Newcastle, Longhurst Campus, August 28, 2002

The distance learning environment, particularly electronic media, can be very helpful in model building. Such an electronic or distance teaching model for schematic knowledge would resemble that shown in Figure 8 below.

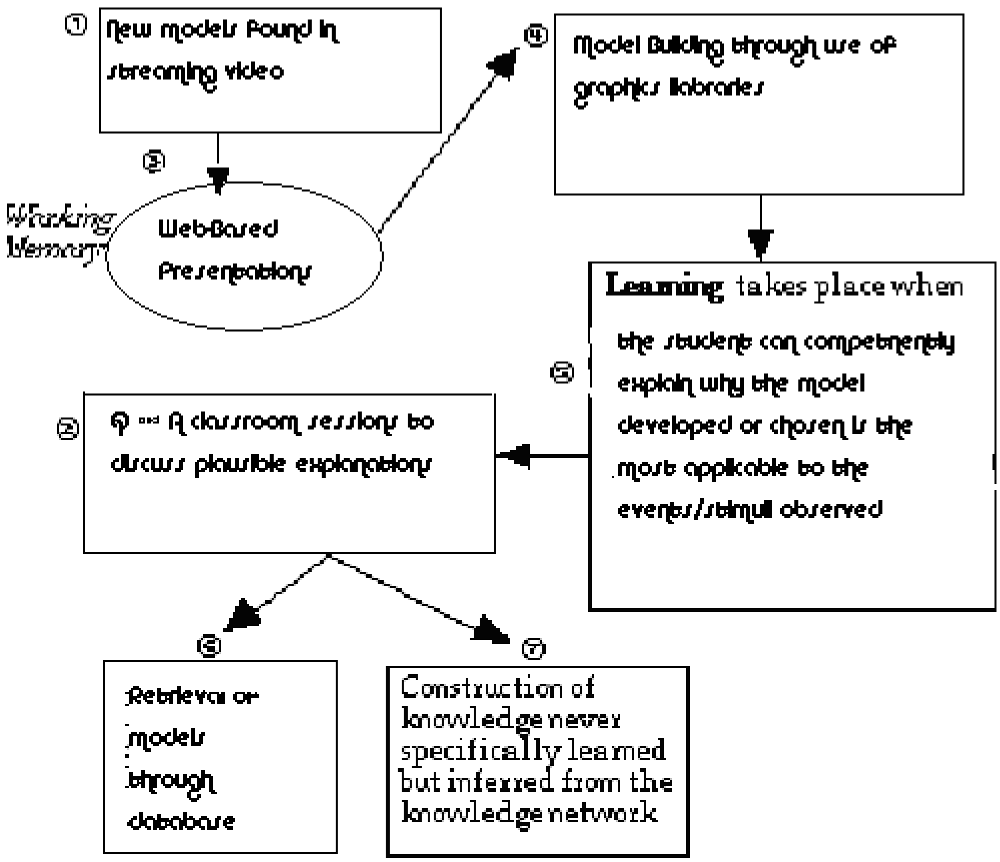

Figure 8—Schematic E-Teaching Model

The E-Learning model provides web support with a database of streaming video database presentations to assist the learner in building a model that illustrates how the concept or principal operates. This model has the advantage of providing a wide array of choices to the leaner and providing exposure to a number of competing explanations and applications, thereby strengthening discrimination ability. The Question and Answer classroom sessions are held to ask any questions that were not covered by the video presentations or to further discuss the rationale for choosing among the various models.

Because the process of discovery of new rules and concepts often involves an iterative process rather than a linear one, it is recommended that a web page be developed for those seeking to learn more about the various models and to better able to compare and contrast them.

Process Knowledge Learning Model

Process knowledge is basically knowledge of how to generate and monitor plans. In the learning model, both students and instructors work together to examine complex problems and construct new knowledge to solve them. In the model, students learn the required information through structured activities that provide some opportunities for students to make their own discoveries and draw their own conclusions.

Learning inquiry skills in this manner naturally leads to collaboration among students. The term "collaborative learning" refers to an instruction method in which students at various performance levels work together in small groups toward a common goal. The students are responsible for one another's learning as well as their own. Thus, the success of one student helps other students to be successful.

A learning model specifying some type of collaboration to sole common problems would resemble the following:

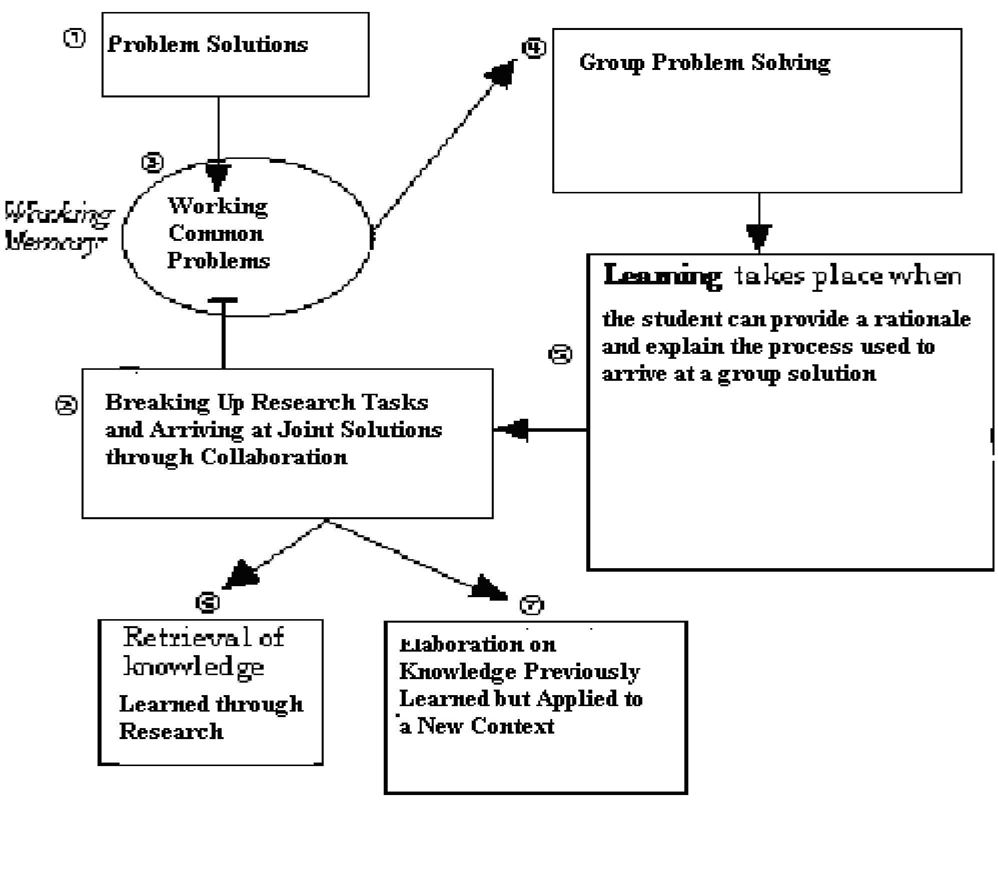

Figure 9—Process Knowledge Learning Model

For collaborative learning to be effective, the instructor must view teaching as a process of developing and enhancing students' ability to learn. The instructor's role is not to transmit information, but to serve as a facilitator for learning. This involves creating and managing meaningful learning experiences and stimulating students' thinking through real world problems.

The teaching model for collaborative learning can take more than one form. In a classroom environment, a communication tool is required for online interactions and software tools are needed to record answers, display solutions, and show the results of solution applications. A collaborative teaching model would thus resemble that shown in 10 below.

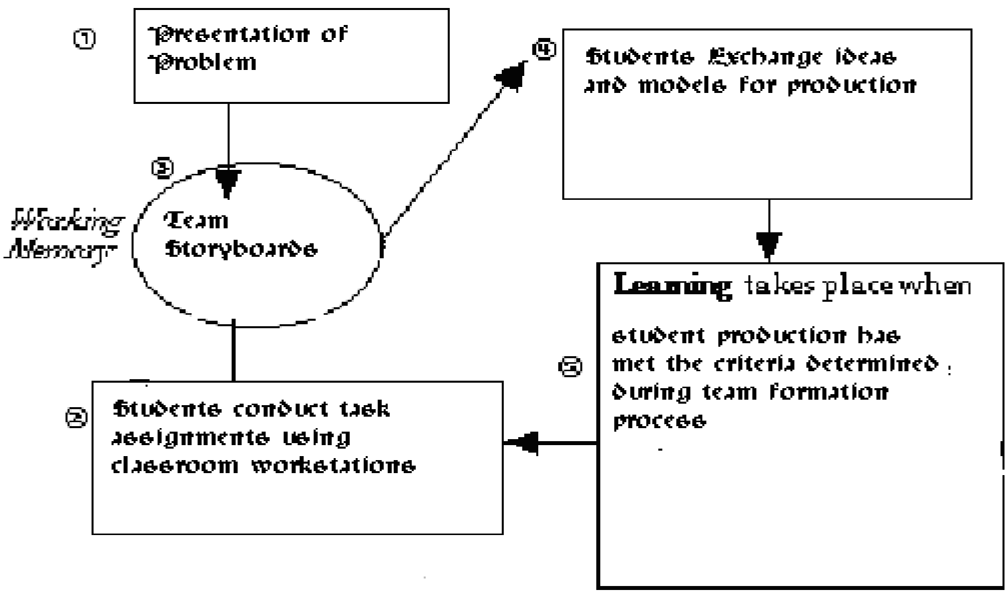

Figure 10—Collaborative E-Teaching Model

A collaborative model allows for a multimedia experience in working toward a common solution using a variety of learning tools. This model is based on one which is used in a computer classroom with student workstations networked to be able to share graphics, text, and production models. A fair amount of pre-production is also assumed to develop storyboards and evaluation criteria which could make use of automated design tools as well. CAM/CAD drawing packages, if both the instructor and students know how to use them are also valuable tools to use in creating team products or models.

Students work directly in virtual spaces and digest the work carried out by students from elsewhere as well as their own classrooms. The teacher guides them in these environments, which are actually Web pages specially designed to support collaborative learning. New pages with illustrations and in some case sound and video images can easily be created and placed in the site server directly by users (teachers or students). As no purchase of intermediate software is required (for example, to publish Web pages) and management of the local technology is cut to the minimum (this is a distance operation), there is normally a nominal per student charge for making use of these web sites.

Conclusion

The results of specifying the creation of a learning environment rather than the required components of a training program allows customization of the program to meet the needs of the target population and to ensure that its content is taught at the appropriate level. Thus, the designer will have a solid framework for making learning environment modification decisions based on proven educational theories and directed at creating a viable learning strategy.

Building the program on a solid framework of proven techniques is a good method of ensuring program success. Additionally, it provides traceability for design decisions if student feedback targets any content that is missing or technique that is inappropriate. This is particularly important in distance learning problems due to the lack of opportunity provided to constantly refine the programs over a series of presentations to a wide variety of students.

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Dr. Vranesh is also a frequent presenter and contributor to Society for Applied Learning Technology publications and meetings and Federal Technology events.