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# SCENARIO-BASED LEARNING AND MULTIMEDIA IN IMPROVING ENGINEERING EDUCATION

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## ABSTRACT

Use of multimedia and new technologies has become very common in education and the corporate training industry. Unlike text-on-the-screen (page-turner) instructions, multi-media based interactions involve audio, video, animation and rich graphics. These attributes are very appealing to learners, and have become the predominant approach to deliver self-paced learning material.

The use of multimedia and computer-based training has improved web-based as well as computer-based training and instructional delivery tremendously. However, providing an authentic learning experience requires much more than multimedia. It requires an active learning approach built on sound principles of instructional design. Scenario Based Learning (SBL) is an effective pedagogical approach which utilizes new technology and provides an excellent framework for active learning.

This paper presents a SBL approach and its application to teach engineering. This approach will engage learners, increase their interest, improve knowledge retention, and facilitate understanding of the physical meaning behind abstract concepts.

Keywords: Scenario-Based learning, E-Learning, Multimedia, SBL

## INTRODUCTION

Researchers assert that learning is valuable and meaningful when learners are engaged and are able to immerse themselves in an authentic learning task [1-4]. In the past, researchers have used multimedia cases and other methods to engage the students in an authentic learning task [5-7]. Results from a National Training Laboratory study indicate the effectiveness of approaches such as "learn- by-doing" and "teaching one-to-one" as shown in Fig. 1.

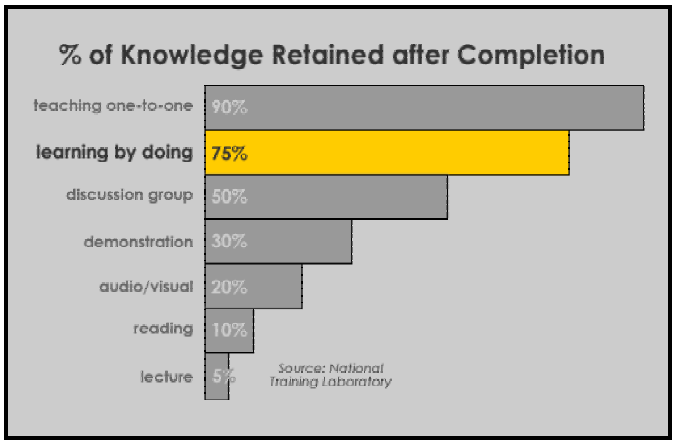


Figure 1 – Knowledge Retention Study

Results of this study (Fig. 1) show that interactive learning environments account for increased knowledge retention when compared to more common methods of instruction. The more common approaches to training (i.e., lecture, reading, audio/visuals, and demonstrations), in contrast, achieve

retention rates of only 5-30%, less than ½ the rate of mentored experiential learning. Even case studies or discussion groups, both common approaches in higher education and adult learning, achieve retention rates of only 50%.

We know that knowledge retention, while necessary for competency achievement, in and of itself is not sufficient. What is needed is an approach to learning that enables the learner to retain knowledge, then to exercise knowledge learned in a controlled, replicable, and safe environment. This allows the learner to apply knowledge, skills and abilities by testing himself/herself in a "real-world setting." Learner guidance, in the way of coaching, can further benefit this approach, thereby increasing its effectiveness.

## E-LEARNING IN ENGINEERING EDUCATION

Use of multimedia in engineering education can, in general, be categorized in terms of lecture delivery method (blended learning), self-paced learning & training material, simulations, and dissemination of reference materials. The types of multimedia tools include, but are not limited to: audio/video recordings, animations, and interactive software or websites. The advantage of these is that the learners can access the information anytime, anywhere. However, in most of these cases, the participation of the learners is limited to reading text-on-screen, answering well-phrased questions, or following directions to repeat a process conveyed by the multimedia tool. Regardless of the approach, these standard tools too often structure learning in a passive way.

Active, experiential learning, using a scenario-based approach offers a new and more effective way of engaging learners and building competency mastery than is true of traditional e-Learning approaches. In addition, technology assures consistent distribution and presentation of SBL. If well produced, the presentation of highly engaging and realistic scenarios, possible courses of action, and plausible outcomes can make scenario-based learning remarkably realistic and both intellectually and emotionally engaging.

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### The Scenario-Based Learning Approach

*Scenario Based Learning* is an effective approach that provides an excellent framework for learn-by-doing. Similar to case-based instruction, SBL utilizes an authentic context in which the problems are presented in certain sequence and choices offered that enable the learner to reach an outcome. Learning occurs as the user goes through various scenarios and is guided to discover principles, and develop critical competencies. Unlike case-based instruction however, SBL generally adheres to a performance improvement imperative rather than the acquisition of knowledge and skills. Engineering students make decisions at various junctures, which impacts their ultimate performance. Furthermore, SBL enables the system to present new scenarios and outcomes based on what a user selects. As with any constructivist approach, mistakes are an integral part of the learning process. In SBL mistakes inform the system which adapts thereby prompting the learner to make better choices in the future.

Research has established that in order for a learner to acquire and retain skills and knowledge, the learner must be placed in a scenario where his/her decisions affect, or alter subsequent events leading to new events, just like in real life [1,4,8-11]. In real life, we are presented with choices everyday; some good, some bad, some ok, and some irrelevant. Choices we make improve, deteriorate our current situation, or, make no difference. In this way, SBL is a form of experiential learning [12].

In the SBL context, a scenario is a realistic situation where a sequence of events is presented and possible choices allow the learner to reach an outcome. Learning occurs when the user goes through the scenario and is guided to discover principles and develop critical competencies. Information and reference modules are presented in context when required or requested. Mistakes can be made and the resulting scenario will allow the user to make subsequent decisions. Learning still occurs if a user takes a wrong path all the way through. Thus learning becomes an experience; users do not blindly follow a set of rules, or learn by rote. Fig. 2 shows an example of a SBL model and Fig. 3 shows how a scenario branches into various outcomes.

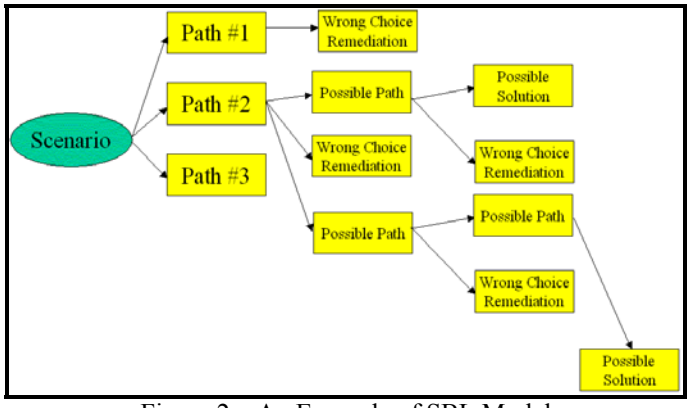


Figure 2 – An Example of SBL Model

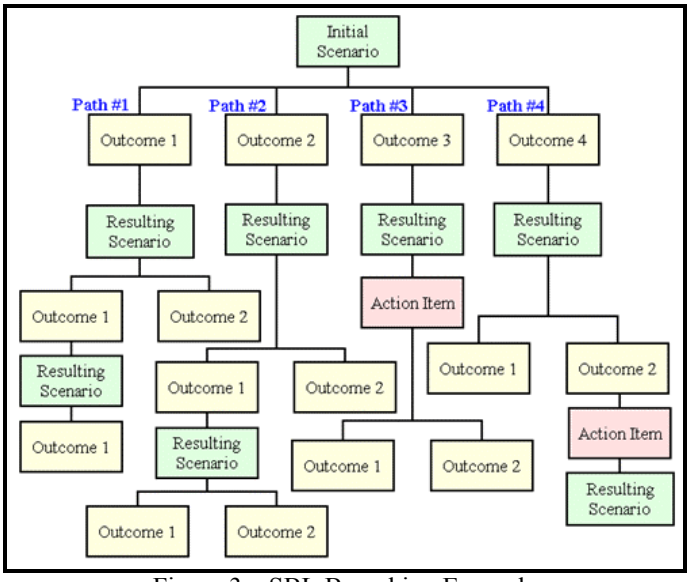

Figure 3 – SBL Branching Example

The premises for using SBL area as follows:

- Reality is the ultimate and best learning experience.
- The overall goal of learning is to transfer knowledge and skill to new situations.
- Learning must be fun and enjoyable like playing a favorite sport.
- Learning must allow for mistakes. No one has ever learned anything without making mistakes. However, current teaching methodologies do not allow for mistakes and look for one correct answer. This popular approach is too simplistic and doesn't reflect reality. The preferred approach is to allow students to commit mistakes but then learn from them.
- Real learning occurs when we can immerse ourselves in a situation in which we are forced to perform, get feedback form our environment, and given chances to correct or adjust our responses.

Scenario-based learning has some characteristics in common with project-based learning [13-14], although they are distinctly different. In particular, the closest approach to scenario-based learning is the story-centered curriculum championed by Robert Shank [8-9] from Carnegie Mellon University (CMU). CMU West is applying this concept to the development of a six-unit network security course. Thus the concept of SBL is not new. However, it has been mostly applied to business courses to analyze *what if* scenarios. To our knowledge, SBL has not been developed or applied systematically to teach engineering courses.

## INTEGRATING MULTIMEDIA AND SBL

The following scenario shows the drama and dilemma that are present in a SBL scenario:

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*The explosion occurred at exactly 9:08 CST, and almost immediately the mayor's phone began ringing. Calls poured in from the media, federal authorities, neighboring jurisdictions, department heads and citizens. Local TV channels began broadcasting from the scene, as police, fire, and emergency medical crews rushed to the disaster.*

*While the city had prepared an emergency response plan, nothing of this scale had ever occurred, and because the city had never gone through a comprehensive drill to prepare for something of this magnitude, the mayor had only instinct and years of management experience to fall back on.*

*Immediately her mind raced with thoughts about where to begin, and how to get control of a situation that could easily careen into chaos.*

- *Should she gather her department heads?*
- *Should she go to the scene?*
- *Should she hold a press conference?*
- *Or, should she begin notifying authorities in other jurisdictions, because this was shaping up to be a major disaster affecting neighboring cities?*

*Knowing that any course of action has consequences, some immediate…some delayed, the mayor needed to quickly assess the best course of action, weigh the tradeoffs, then make decisions in order to minimize loss of life and further damage to property …but she needed to choose quickly!*

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In this fictitious story, there are many key elements for an effective simulation exercise or scenario-based learning experience (i.e., drama, dilemma, and a focus on performance). Incorporating scenario-based simulations can add richness and relevance to the learning experience while achieving the ultimate goal of preparing learners to perform more effectively in "real life."

With technology, we can recreate the above story in an interactive, "video game" environment, where the learner can control the action of the mayor. For example, the learner might play the role of the mayor in the game. In doing so, they actively participate in the decision-making process which influences the outcome of the city. The multimedia game environment offers a learning background that is as close to real life as possible, and the SBL entices the user to learn through active participation.

## A DESIGN EXAMPLE

The following engineering design example [15] utilizes a SBL approach and allows learners to explore and experiment with different possibilities before reaching the most appropriate answer. Fig. 4 describes the initial scenario (problem statement) using multimedia animation. Figs. 4 through 8 show various options available to the user and the system's response to user input. Notice Fig. 6 provides feedback to users so they may backtrack as well as allow them to explore new options. In addition, relevant resources related to that topic are available. Fig. 9 shows the SBL branching scheme for this design process. In Fig. 9, node A is the scenario described in Fig. 4. Nodes B through E are the possible design options of an assembly line which include a Robot (B), Cam (C), Linkage (D) and others (E). Nodes F through K represent different designs of the linkage, and nodes L through R are the outcomes due to the linkage design.

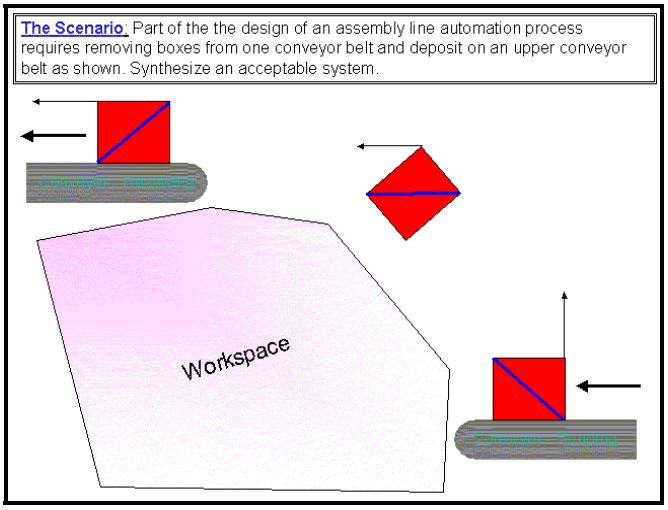


Figure 4 – The Task

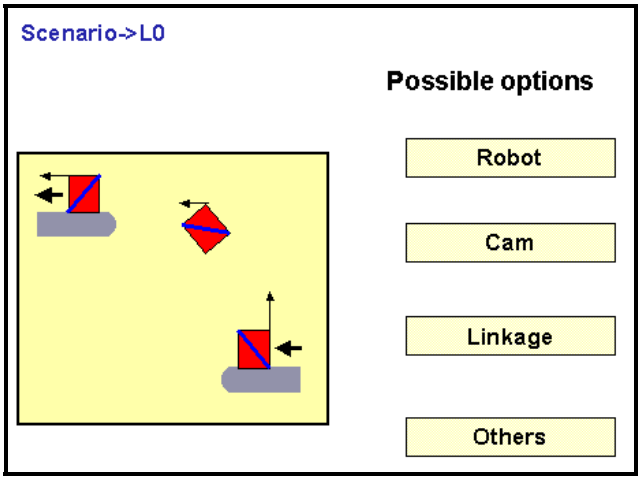


Figure 5 – Possible Options

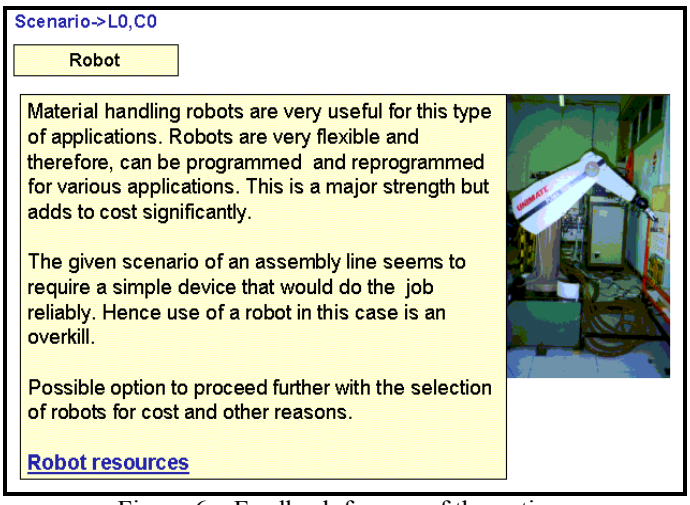


Figure 6 – Feedback for one of the options

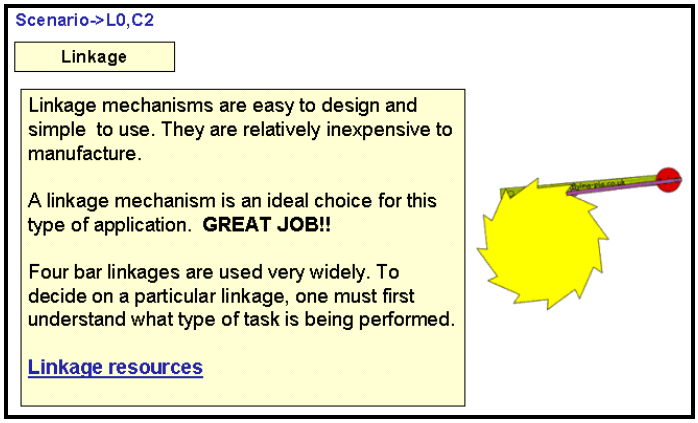


Figure 7 – Feedback for linkage option

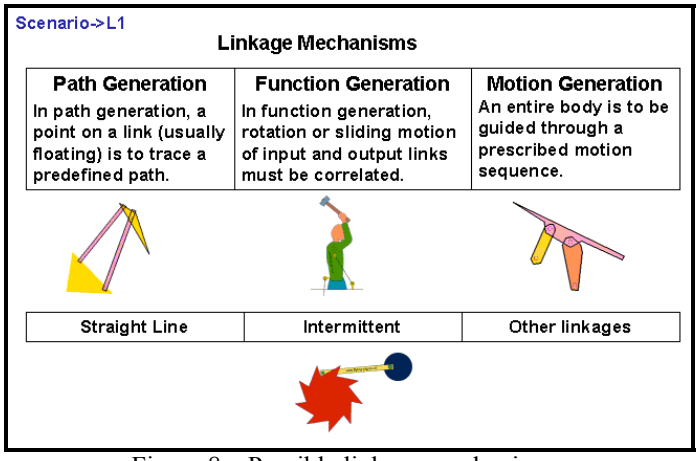


Figure 8 – Possible linkage mechanisms

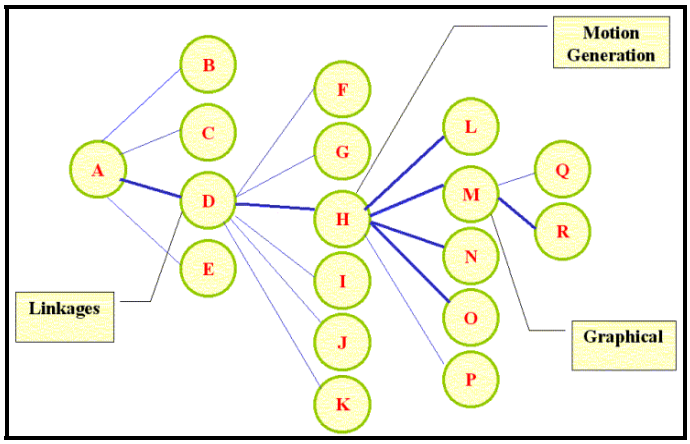


Figure 9 – Mechanism Design Example Branching

## CONCLUSION

Well-crafted scenarios improve learner retention, improve performance, and induce learners to continue to use the scenario to practice requisite skills. A well-designed scenario both intellectually and emotionally engages the learner, increasing motivation, knowledge acquisition, and most importantly the ability to synthesize and apply knowledge with prudence. Good scenarios also ensure that learners can practice in a safe, yet lifelike environment, and can be comfortable experimenting with different approaches. Even the unsure, the

timid, the shy and the novice learner can practice crucial skills without embarrassment.

A thorough and well-designed and planned scenario could serve as the foundation for a course, or simply be a way to supplement existing course material. Furthermore, with a well-developed process and a user-friendly tool, instructors, subject matter experts and instructional designers could convert existing cases, or fashion altogether new scenarios to a web-based approach.

A web-based or computer-based scenario ensures consistency, yet provides for a reasonable level of variation in experience, so that learners can experiment. It addresses the shortcomings of most e-Learning and traditional computer-based training. Starting with an instructional model that places learners rather than instructors at the heart of the learning experience, utilizing a "learn-by-doing" model, SBL enables the learners to practice critical competencies in a safe, but lifelike setting. Through virtual coaching, learners can be guided to make sound judgments, by integrating and applying the skills, rules, procedures, principles and concepts in an optimal way, given context and typical real-world tradeoffs. As learners gain proficiency, they can practice these competencies unaided by the "coach." Learners can have access to resources within the simulation, which they can access through guided discovery, then use as aids in navigating through a scenario to achieve the desired outcome. Those resources can be a combination of reference materials, applications, or even e-Learning modules.

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