# SPeAR, Anchor, Scaffold, Thread: Learning Design for Scenario-Based Serious Games

**Dr. Michael W. Freeman**
**Camber Corporation**
**Fayetteville, NC**
**mfreeman@camber.com**

**Ms. Angie White**
**Camber Corporation**
**Newport News, VA**
**awhite@camber.com**

## ABSTRACT

Scenario-based serious games are a promising medium for providing direct experience and concrete contexts in military training environments. However, there are few research-based guidelines to support their learning design or account for why they include specific characters, environments, or activities. While the fundamentals of good instructional design and learning are enduring, the design of scenario-based serious games requires a different, holistic approach to leverage their great promise and inherent power.

This paper will describe an industry research and development initiative to produce an integrated methodology for designing scenario-based serious games while also providing a common lexicon for designers, developers, project managers, customers, users and stakeholders to communicate the role and relative importance of product elements and aspects. The methodology is based on a review of learning theories and methods that led to the identification of seven interconnected attributes of scenarios for serious games (Focus, Action, Relevance, Support, Anchoring, Evaluation, and Engagement). The SPeAR Design Methodology was then developed to provide a framework for implementation of the seven attributes through its four interconnected components: SPeAR Statement (Situation, Precipitating event, Action, and Results), Anchor, Scaffold, and Thread. The SPeAR Statement focuses design on active performance of the learning objective, while the Anchor provides the context, the Scaffold provides the support, and the Thread unifies the components into a meaningful learning experience. This paper will conclude with recommendations for continued research and implementation.

## ABOUT THE AUTHORS

**Michael Freeman** has over twenty-five years of international, operational, academic, business and strategic planning experience. Prior to assuming his duties with Camber Corporation in October, 2006, he was Deputy Director and program manager for technical support of the Advanced Distributed Learning (ADL) Initiative for the Office of the Secretary of Defense (OSD). There he was responsible for coordinating the efforts of the ADL Co-Laboratories, overseeing technical support contractors and establishing effective working relationships with stakeholder organizations. A career Army officer, Mike received a Doctorate in Technical Education from Clemson University. He is a certified Defense Acquisition Professional in Program Management and a graduate of the U.S. Army Command and General Staff College, the Army Management Staff College and Army Engineer Officer Career Courses.

**Angie White** possesses almost a decade of experience in the field of distance learning as an Instructional Systems Designer (ISD) with Camber Corporation. She has extensive experience in the design and development of scenario-based learning at multiple levels of interactivity, from passive (level 1) to real time participation (level 4). Prior to joining Camber Corporation, Angie served more than 8 years as a Soldier in the United States Army. She then went on to pursue a Master of Science in Education, with a concentration in Instructional Technology, at Virginia Polytechnic Institute and University.

# SPeAR, Anchor, Scaffold, Thread: Learning Design for Scenario-Based Serious Games

**Michael W. Freeman**
**Camber Corporation**
**Fayetteville, NC**
**mfreeman@camber.com**

**Angie White**
**Camber Corporation**
**Newport News, VA**
**awhite@camber.com**

## INTRODUCTION

Scenario-based serious games are a promising medium for providing direct experience and concrete contexts in military training environments. While the fundamentals of training and learning design are enduring, the design of scenario-based games for learning requires a different, more holistic approach to leverage the great promise and power inherent in game design and methods (Johnson & Wang, 2007). However, there are few specific, research-based guidelines to support their learning design or account for why they include specific characters, environments, or activities (Federation of American Scientists, 2006a).

This paper describes an industry research and development initiative to produce an integrated methodology for designing scenario-based serious games while also providing a common lexicon for designers, developers, project managers, customers, users, and stakeholders to communicate the role and relative importance of product elements and aspects.

## SCENARIO-BASED SERIOUS GAMES

Games have little utility to training and education if the learner fails to achieve the learning objectives set forth in the instructional plan. Success in serious games is the combination of sound learning theory and practices with leading edge technology.

The objective of a scenario-based serious game is to immerse and engage the learner in a realistic setting that presents authentic situations and relevant tasks. Effective game-based learning links task performance to the larger mission, the context in which learning will take place, cues to indicate the need and timing for activities, and ultimately the results achieved. The strategy allows learners to use higher-order critical thinking skills as they make choices and experience the consequences of those choices (Federation of American Scientists, 2006b).

## IMPORTANCE OF SCENARIOS FOR SERIOUS GAMES

Scenarios provide the cues to indicate the need and timing for learners to perform a learning activity, the context in which learning occurs, and the relevance of task performance to the larger learning requirement and unit mission. Scenario-based learning design, also known as story-based or narrative learning design, provides all these components as part of learning products. Context and relevance in serious game scenarios are often developed and presented as “cut scenes” or lead in movies. Screen shots from serious game scenario elements are depicted in Figure 1 below.

**Figure 1: Screenshots from Typical Serious Game Scenario Elements**

## RESEARCH AND DEVELOPMENT INITIATIVE

More and more government and military organizations are demanding increasing levels of complex scenario-based design and games in learning products and services (Committee on Modeling and Simulation for Defense Transformation, 2006). In response, the SPeAR Design Methodology was developed.

SPeAR is an innovative methodology intended to produce compelling, complex scenario-based content that provides the context, relevance, and cues necessary for critical task performance learning and effectively applies research-based best practices in the design and development of scenario-based learning and games. SPeAR also offers designers and developers a common lexicon in the design and development of scenario-based learning and in the communication of expectations to the customer.

Development of the methodology began with the research of a number of widely respected and accepted educational theories related to scenario-based learning and the extraction of best practices from each of those theories. A detailed analysis of those best practices resulted in the identification of seven common attributes of scenario-based learning: Focused, Active, Relevant, Supported, Anchored, Evaluated, and Engaging. The SPeAR Design Methodology was developed to provide the framework for implementation of the attributes.

## RELEVANT THEORIES AND BEST PRACTICES

The first step in the development of the SPeAR Design Methodology involved researching a number of key learning theories related to adult and scenario-based learning and extracting best practices from each of those theories. The researched theories included:

- Anchored Instruction
- Cognitive Load Theory
- Constructivist Learning Theory
- Criterion-Referenced Instruction
- Experiential Learning Theory
- Model-Centered Instruction
- Situated Learning Theory

### Anchored Instruction

The primary objective of the anchored instruction theory is to overcome the problem of inert knowledge. Inert knowledge is knowledge than can be recalled when learners are prompted to recall it, but is not actively used to solve problems, even though it may be relevant.

Anchored instruction serves to overcome the problem of inert knowledge by anchoring instruction within a meaningful context, such as a case study or problem. Learning that is anchored in a realistic situation is much more likely to be active rather than inert. Therefore, learning activities should be centered on a case study or larger mission or problem (Bransford, Sherwood, and Hasselbring, 1988).

### Cognitive Load Theory

When new information is presented, it is stored in short-term or working memory and, if kept, transferred to the internal schematic structures of long-term memory. But the working memory can only process a few items of information at a time. Cognitive Load Theory focuses on techniques for minimizing the load on the working memory in order to assist in the transfer of information to long-term memory (Sweller, 1988).

One approach to implement the Cognitive Load Theory is to reduce the working memory load associated with having to remember less important information by providing appropriate references and performance aids.

### Constructivist Learning Theory

In constructivist learning theory, knowledge and performance are based on learner experience and context (Bruner, 1996). Because of this, the Constructivist Learning Theory "advocates that comprehension and meaning be built gradually using experiences and contexts that help students become willing and able to learn" (Butler & McCahan, 2005). Therefore, instruction should be designed to be based in the context of the learner's situation (making learner willing) and related to the learner's experience (making the learner able).

### Criterion-Referenced Instruction

A major principle of Criterion-Referenced Instruction is that instructional objectives are derived from job performance and reflect the competencies that must be learned (Kearsley, 2008). A Task Analysis is critical in identifying all of the important or relevant elements of a task or job. Each task involves a series of actions that lead to a meaningful outcome. Learning objectives are derived from the results of the Task Analysis, thus directly relating to job performance.

Criterion-Referenced Instruction stresses that learners are given opportunities to practice each objective and obtain feedback about the quality of their performance (Mager & Pipe, 1979). Practice and feedback encourages a higher level of thinking, reduces uncertainty, and provides an opportunity for reflection and self-remediation.

**Experiential Learning Theory**

Experiential Learning Theory differentiates between two types of learning: cognitive (meaningless) and experiential (significant). Cognitive learning involves academic knowledge, such as lecture and memorization. Experiential learning involves the application and experience of knowledge (Rogers, 1961). As a result, instruction should be designed to be active and relevant to the learner.

Experiential learning theory also holds that learning occurs when learners participate completely in the learning process and learning is primarily based upon direct confrontation with practical, social, personal, or research problems (Rogers, 1969). Therefore, we should design instruction that focuses on a relevant problem that the learner must actively solve.

**Model-Centered Instruction**

Model-Centered Instruction provides authentic systems and environments for the learners to interact with during instruction. Learner interaction should involve solution of learning objective focused problems that naturally occur within the confines of the systems and environments (Gibbons, 1998)

Instructional designers should provide learners resources that supply information directly relevant to problem solution. In addition, learners should be tracked and evaluated during problem solving. Based on these evaluations, learners should be offered helpful coaching, feedback, interpretations, explanations, or other instructional augmentations to the problem solving experience (Gibbons, Nelson and Richards, 2000).

**Situated Learning Theory**

Situated Learning Theory is founded on the premise that learning is a function of the activity, context, and culture in which it occurs. Learning should not be viewed as simply the transmission of abstract information, but a social process. Learning should be presented in an authentic context and relevant social/physical environment that the performance of the learning objective naturally occurs (Lave and Wenger, 1991).

Also, learning requires social interaction and collaboration. As learners become involved in a community of practice, the learner begins to embody the beliefs and behaviors of that community. Initially, learners join a community as a novice, interact, learn, and gradually move to the community's center, becoming more active and engaged.

## ATTRIBUTES OF EFFECTIVE SCENARIOS FOR SERIOUS GAMES

A detailed analysis of the learning theories and best practices above resulted in the identification of seven interconnected attributes of effective scenario-based serious games: Focused, Active, Relevant, Supported, Anchored, Evaluated, and Engaging. These attributes were carefully described to insure alignments with each of the learning theories (see Table 1).

**Table 1. Learning Theory/Model to Attribute Cross Reference**

| LEARNING THEORY/MODEL | ATTRIBUTE SUPPORTED | | | | | | |
|---|---|---|---|---|---|---|---|
| | Focused | Active | Relevant | Supported | Anchored | Evaluated | Engaging |
| Anchored Instruction | | | X | | X | | |
| Cognitive Load | | | | X | | | |
| Constructivist Learning | | | X | | | | X |
| Criterion-Referenced Instruction | X | | X | | | X | |
| Experiential Learning | X | X | X | | | | |
| Model-Centered Instruction | | X | | | X | X | |
| Situated Learning | | X | X | X | | | X |

**Focused**

Effective scenario-based learning is focused on the learner, the learner's master of the learning objective, and the solution of a well-crafted problem.

**Active**

Scenario-based learning requires the learner's active performance of the learning objective toward the solution of a problem.

**Relevant**

Effective scenario-based learning is relevant and includes with environments, characters and problems that are believable, authentic, accurate, and appropriately complex. This gives the learner the opportunity to practice and reinforce performance tasks in settings that reflect the application environment.

**Supported**

Purposeful cognitive support is provided for learners through the use of interaction and collaboration with mentor and peer avatars. Job aids and performance support are also provided to allow learners to focus on the larger picture instead of rote memorization of lower order information.

**Anchored**

Scenarios are anchored in a larger performance problem and mission in the context of a common back story. This larger mission provides the context for the problems to be solved by the learner and the actions taken to solve them. A story thread is woven through all scenarios to provide continuity and reduce the cognitive load required to make appropriate performance decisions. The story thread progresses and unifies the narrative to a culminating resolution.

**Evaluated**

Effective scenario-based learning provides evaluation and feedback by requiring the learner to solve problems. Appropriate feedback encourages a higher level of thinking, reduces learner uncertainty and is necessary for the learner to maintain a sense of control. It also provides opportunities for reflection through the use of after-action-review methods and provision of a culminating resolution showing the results of performance.

**Engaging**

Each problem is carefully contextualized through the development of storylines and narratives that link learner actions to larger collective missions and campaigns. Major characters are developed in accordance with their role in the learning process to improve the instructional effectiveness of avatars. Dramatic and cinematic techniques are employed to weave the story thread through each module, lesson, learning activity and evaluation to make learner actions plausible and build commitment to mission accomplishment.

## COMPONENTS OF THE SPeAR DESIGN METHODOLOGY

The SPeAR Design Methodology includes four interconnected components: SPeAR Statement and the supporting components Anchor, Scaffold, and Thread. These components provide the framework for implementation of the seven attributes of effective scenario-based learning (see Table 2).

**Table 2. SPeAR Design Methodology Component to Attribute Cross Reference**

| SPeAR Design Methodology Component | Attribute Supported | | | | | | |
|---|---|---|---|---|---|---|---|
| | Focused | Active | Relevant | Supported | Anchored | Evaluated | Engaging |
| SPeAR Statement | X | X | | | | | |
| Anchor | | | X | | X | | X |
| Scaffold | | | | X | | X | |
| Thread | | | X | | X | | X |

**The SPeAR Statement**

The foremost of these components, a SPeAR statement written for each learning objective, ensures learning outcomes. Looking at the SPeAR Design Methodology as a building structure, the SPeAR statement serves as the roof of a serious games house (see Figure 2).


**Figure 2: SPeAR Statement: Roof of the SPeAR Design Methodology House**

The SPeAR Statement is a concise statement of the Situation, Precipitating event, Action, and Results necessary for learning. The statement focuses on active performance of the learning objective by the learner and provides the basic accountability for the learning design. A description of SPeAR elements is below.

**Situation**

The Situation provides the context and relevance to set the stage for the learning process.

**Precipitating Event**

The Precipitating event provides the cue and stimulus for the student to perform the actions required to solve a problem.

**Action**

The Action is the performance required of the learner to master the learning objective and demonstrate mastery for evaluation.

**Results**

Results are the outcomes of the learner taking the objective focused action.

**SPeAR Design Activities**

Typically, SPeAR designed activities include the statement elements (Situation, Precipitating event, Action, and Results) along with evaluation and, if necessary, remediation (see Figure 3).

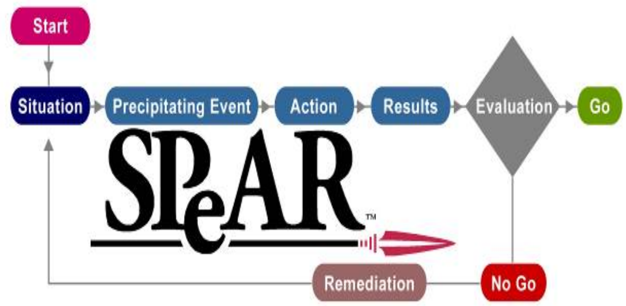


**Figure 3: Typical SPeAR Designed Activity**

**The SPeAR Supporting Components**

While SPeAR statements are critical to learning design and accountability of the game in meeting the learning objective, they are insufficient to leverage the power of serious games or to describe the role of all elements of serious games. There are also 5 of 7 attributes (Relevant, Supported, Anchored, Evaluated, and Engaging) that are not directly addressed by the SPeAR statements alone. To address these attributes, the supporting components of Anchor, Scaffold, and Thread were developed.

These supporting components can be thought of as the columns that support the SPeAR statement roof of the serious games house (see Figure 4).

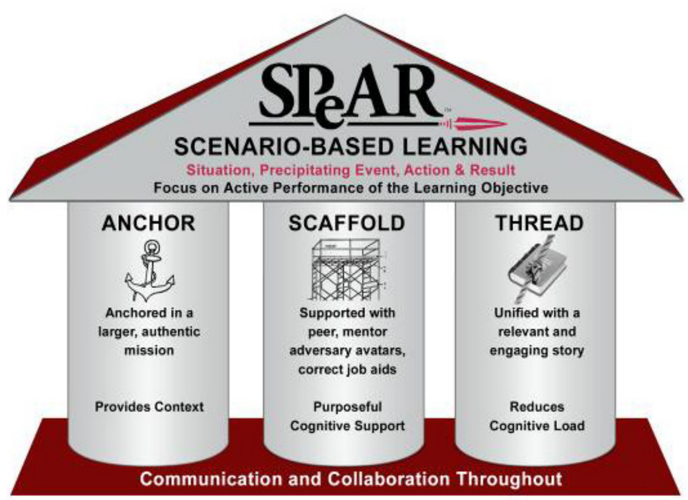


**Figure 4: Anchor, Scaffold and Thread: Supporting Components of the SPeAR Design Methodology House**

**Anchor**

The Anchor provides the larger, authentic mission that provides the context for all aspects of the learning activities. In military learning design, this is usually the mission of the higher unit (see Figure 5).

**Figure 5: Example Anchor Mission Brief**

**Scaffold**

The Scaffold provides purposeful cognitive support to the learner through the use of peer, mentor and adversary avatars as well as realistic job aids such as checklists and technical manuals. The scaffold is intended to be removed as the learner progresses in mastery of the skill. An example Scaffold mentor avatar is shown in Figure 6 below.

**Figure 6: Example Scaffold Mentor Avatar**

**Thread**

The Thread provides a relevant and engaging story which progresses the learner between activities and unifies the learning experience. An example Thread engaging story screen capture is shown in Figure 7 below.

**Figure 7: Example Thread Engaging Story**

**Foundation**

Finally, the foundation of the entire methodology is communication and collaboration among the game stakeholders, to include the customer, instructional designers, graphic artists, animators, and learners.

## RECOMMENDATIONS FOR CONTINUED RESEARCH AND IMPLEMENTATION

While the SPeAR Design Methodology accounts for learning objectives and scenario related elements, it does not address the elements of game dynamics or pure game play considerations. Therefore, the methodology should be extended by reviewing the literature related to game dynamics and game play followed by incorporating those elements into SPeAR, possibly as a supporting component in the SPeAR Design Methodology house.

## CONCLUSION

The innovative SPeAR Design Methodology enables the intentional design and development of scenario-based learning game play that is matched to learning and performance goals. SPeAR also provides the context, relevance, and cues necessary for learning while implementing the seven attributes of effective learning scenarios (Focused, Active, Relevant, Supported, Anchored, Evaluated, and Engaging). Perhaps more importantly, it provides a common lexicon for stakeholder communication and agreement on what's important in serious game scenarios and why. Using this lexicon, an audit trail can be developed for all elements in the scenario while maintaining a focus on active performance of the learning objective by the learner.

**ACKNOWLEDGEMENTS**

We thank the Camber Strategy and Business Development Council for funding this Internal Research and Development project. We also thank the management of the Camber Training, Technology and Systems Group as well as the Operations, Training and Testing Division for their support and guidance.

**REFERENCES**

Bransford, J., Sherwood, R., & Hasselbring, T. (1988). The video revolution and its effects on development: Some initial thoughts. In G. Foreman and P. Pufall (Eds.), *Constructivism in the computer age* (pp. 173-201). Hillsdale, NJ: Lawrence Erlbaum Associates.

Bruner, J. (1996). *The culture of education*. Cambridge, MA: Harvard University Press.

Butler, J., & McCahan, B. (2005). Teaching games for understanding as a curriculum model. In L. Griffin & J. Butler (Eds.), *Teaching games for understanding: Theory, research, and practice* (pp. 33-54). Champaign, IL: Human Kinetics.

Committee on Modeling and Simulation for Defense Transformation. (2006). *Defense Modeling, Simulation, and Analysis: Meeting the Challenge.* Washington, DC: National Academies Press.

Federation of American Scientists. (2006a). *R&D challenges in games for learning*. Washington, DC: The Learning Federation.

Federation of American Scientists. (2006b). *Harnessing the power of video games for learning*. Washington, DC: The Learning Federation.

Gibbons, A. (1998). Model-centered instruction: Beyond simulation. In M. Marquardt & G. Kearsley (Eds.), *Technology-based learning: Maximizing human performance and corporate success* (pp.138-139). Boca Raton, FL: CRC Press.

Gibbons, A., Nelson, J., & Richards, R. (2000). *The architecture of instructional simulation: A design for tool construction*. Center for Human-System Simulation Technical Report, Idaho Falls, ID: Idaho National Engineering and Environmental Laboratory.

Johnson, T., & Huang, W. (2007). Instructional gaming effects on learning outcomes. *Proceedings of the 2007 Interservice/Industry Training, Simulation, and Education Conference (I/ITSEC), Orlando, FL.*

Kearsley, G. (2008). *Explorations in learning & instruction: The theory into practice database*. Retrieved June 8, 2008, from http://tip.psychology.org

Lave, J., & Wenger, E. (1991). *Situated learning*. New York: Cambridge University Press.

Mager, R., & Pipe, P. (1979). *Criterion-referenced instruction: Analysis, design, and implementation*. Los Altos Hills, CA: Mager Associates, Inc.

Rogers, C. R. (1961). *On becoming a person. A therapist's view of psychotherapy.* Boston: Houghton Mifflin.

Rogers, C. R. (1969). *Freedom to learn*. Columbus, OH: Merrill.

Wolfgang, S., & Kürschner, C. (2007). A reconsideration of cognitive load theory. *Educational Psychology Review, 19*, 469–508.

Sweller, J. (1988). *Cognitive load during problem solving: Effects on learning*. Cognitive Science, 12, 257--285.