Available online at www.sciencedirect.com

ScienceDirect

Procedia Manufacturing 3 (2015) 4121 – 4128

Procedia MANUFACTURING

6th International Conference on Applied Human Factors and Ergonomics (AHFE 2015) and the Affiliated Conferences, AHFE 2015

Motivating narrative representation for training cross-cultural interaction

Robert E. Wray*, Jeremiah T. Folsom-Kovarik, Angela Woods, Randolph M. Jones

Soar Technology, 3600 Green Court, Suite 600, Ann Arbor, MI 48105, USA

Abstract

Scenario-based training provides valuable opportunities for practice and assessment of cross-cultural skills in representative environments. Cross-cultural training that is presented within scenarios can help to motivate trainees and to increase perceptions of relevance and validity. Further, with immersive computer simulations, a sufficiently rich representation can enable tailoring of content, delivering support or challenge for individual trainees when scenario events play out in a variety of ways. However, training scenarios delivered via a computer simulation can be difficult for end users such as instructors to createor tochange after they are created. One source of this difficulty is the lack explicit representation of the goals of training or rationales for their design. As a consequence, technical personnel are typically required to make changes, resulting in a process that is costly, slow, and prone to communication errors. Further, training scenarios can become obsolete or fail to reflect the varied needs of different instructors. In this paper, we identify specific limitations to the scenario definition and describe an alternative approach based on computational narrative. The new approach is designed toenable a training system to reason about *what*training content to tailor and *why*to deliver suitably tailored and individualized training.

Peer-review under responsibility of AHFE Conference

*Keywords:*Simulation-based training; Training scenarios; Computational narrative

* Corresponding author. Tel.: +1-734-327-8000.
E-mail address: wray@soartech.com

Peer-review under responsibility of AHFE Conference
doi:10.1016/j.promfg.2015.07.985

1. Introduction

Scenario-based training provides valuable opportunities for practice and assessment of cross-cultural skills in representative environments[1-4]. It is also presumedthat scenario-based cross-cultural training helps motivate trainees and increases perceptions of relevance and validity (although more research is needed[5]). Scenarios provide valuable context that is hypothesized to improve training outcomes for skills such as cue recognition, performance under realistic pressures, and transfer to a real-world setting[3]. Scenario-based, cross-cultural training allows persistent characters and a consistent narrative, letting trainees practice specific target skills in a context that is representative of real-world tasks. Further, immersive computer simulations coupled with a sufficiently rich scenario representation enable *dynamic tailoring* of training content, either supporting or challenging individual trainees on demand, via manipulation of scenario events, character actions, and player action outcomes [6-8].

Simulation can play an important role in developing cross-cultural skills. However, training scenarios delivered via computer simulation currently have significant limitations. They are often “canned,” allowing little variation in their progression and ability to respond to varying trainee actions. They can be difficult for end users such as instructors or instructional designers to change after they are created, requiring the support of technical personnel. The resulting process is costly, slow, and prone to communication errors. As a consequence, training scenarios can become obsolete or fail to reflect the varied needs of different instructors.

We contend that a primary cause of these limitations is the gap between an instructor's concept of a “training scenario” and what is typically represented as a “scenario”computationally in a simulation-based training system. The representation in the simulation system usually focuses largely on *how* to implement an instructional event. However, it is unusual for the simulation system to represent explicittraining goals (the *what*) and rationales (the *why)* for those entity and event choices. As a consequence, the resulting computational scenarios are difficult to modify and not robust when changes are attempted. The difficulty is often characterized as deriving from limited technical (programming) skills of instructional staff. However, another contributing cause is thatinstructional design concepts such as training goals and rationales are not represented in the computational implementation.

To address this gap, we are exploring computational narrative representation as a tool for representingsimulation-based training scenarios. In a training context, we use *narrative*to mean the interactions of trainee actions and environment events that culminate in the achievement of training objectives. The use of computational narrative provides astructure to reason about and to adapt to trainee actions so that training goals can be met.

In order to ground the discussion, we introduce a simulation-based training prototype that exemplifies tailored cross-cultural training in a military visual perceptionand observation setting. We introduce the narrative representation for this system and describe how it allows definition of cross-cultural scenarios. This first attempt at an *instructor authorable narrative representation* is somewhat limited in its expressivity, but is reasonably wellmatched to the requirements of this domain. We also outline future directions for extending the representation to more general cross-cultural training situations and simulations.

2. Simulation-based training scenarios

A training scenario typically allows trainees to practice or to demonstrate specific combinations of skills. For example, a Marine Corps Training and Readiness syllabus might suggest that a small unit needs to practice particular sets of skills together in particular settings. Depending on the training context, a small unit leader, an instructor, or an instructional designer would then create or adapt existing exercises to practice those skills. In live training situations, such as Border Hunter [9], instructors create a series of events that are staged by live actors to reflect increasing learner skill and the progressive introduction of new skills. There is often also an overall narrative framing. As an example of framing, the instructors might plan some concerted activity of “coyotes” to divert border patrol resources from actual incursion areas. Based on observations of the individual trainees by the instructional team, instructors will customize the training as it proceeds, adapting the planned sequence and specific events to emphasize or to remediate certain skills or to challenge groups with higher skill levels.

As this example suggests, in the live training context, the detailedtraining “scenario” is worked out dynamically as the instructional team observes trainee performance. The instructors can consider the goals of the training (e.g., as specified by the training and readiness matrix) and consider how to best meet those goals in the context of a particular training event. Because human role-players are adaptable and can take direction, instructors need no specialized technical skills to deliver a training experience that meets the formal requirements and tailors training to the needs of the trainee.

This dynamic interplay is almost wholly lost in today’s simulation-based training. The typical design and development workflow is illustrated in Figure1a. An instructor (or more typically, an instructional-design team) createsartifacts that map experiences to a set of skills,such as a training and readiness (T&R) matrix. These artifacts usually include written documentation that explains how and why this training experience meets the desired training goals. In the usual case, adistinct and separatesoftware development team implements a situation in the simulation environment intended to satisfy the instructional design. The instructional goals are not usually explicitly coded into the computational representation. Further, it is often the case that resource constraints limit the development team from fully implementing the intended design[10]. For example, art assets may not be readily available (and may be cost-prohibitive to create), leading the development team to approximate some of the design, or constraints in the simulation engine itself may require workarounds in the implementation of the training experience. The instructor may not be aware of these limits.

Table 1. Examples of information embedded in a representative simulation-based scenario file.

Scenario Data	Description
Terrain	Representation of the terrain, which is usually geotypical, not geospecific.
Environment	Environmental information such as starting time of day and weather conditions.
Objects	Static objects (buildings, foliage, etc.) and their properties (e.g., brick or wooden building).
Vehicles	Starting location and vehicle type. Some vehicles can be selected or controlled by the player at run-time.
Non-player characters	Starting location and properties of each individual in the scenario. Properties include basic settings such as gender, clothing and supplies the entity is carrying such as weapons, ammo or medical kits.
Interactions	Cause and effect interactions are encoded using physical triggers, simple spatial zones that can be tested for proximity, entrance and exit, and used to produce basic reactive behavior in entities that trip the conditions of the trigger.
Behavior scripts	Scripts that explicitly specify precise NPC behavior and timing for a scheduled set of non-reactive behavior. For example, a specific character should emerge from a building 2 minutes after scenario start.
Movement	Markups of terrain that name specific points in the terrain (waypoints) and paths between waypoints (routes).
NPC behaviors	Assignment of built in behaviors that are typically tightly coupled to the assumptions of a narrow band of use cases and provide minimal configuration options. The most common ones include squad based movement and tactics.
Waypoint triggers	Behavior tied to waypoints in routes (e.g., when a specific point is reached, play a specific animation).

The end product of this design and development process is typically termed a *training scenario*. In many distributed simulations and virtual environments, a product of the development process is a “scenario file” that encodes the details.

Table 1 enumerates some of the classes of information found in a typical scenario file. This specification of the “training scenario” is quite different from the "training scenario" that is produced in a live training environment (Table 2). Consider two broad differences:

- Level of description: In comparison to live training, where the basic “beats” of the training is (largely) what is mapped out in advance, the simulation-based training scenario is specified at a lower level of description. This level of detail results in loss of flexibility in part because detailing all the content is time- and resource-intensive.
- Absence of training-relevant content: Notably absent in the table is any specification of training objectives or a mapping between the elements in the files and their effect or relationship to the training goals. In some cases, there may be some specification of the “type” of mission such as “room clearing.” Generally, however, the association between what the trainee is expected to do and accomplish and what the non-player-characters (NPCs) and simulation events are configured to execute is entirely implicit.

Importantly, an instructor's ability “in the field” to tailor a simulation-based scenario to a particular group of trainees is typically limited to (at best) choosing from a few pre-scripted options. Limited extensibility inhibits an instructor from adapting the curriculum to suit what has proven to work well,or not,in practice, as well as to update the curriculum to reflect evolving tactics, techniques and procedures (TTPs) and instructional priorities.

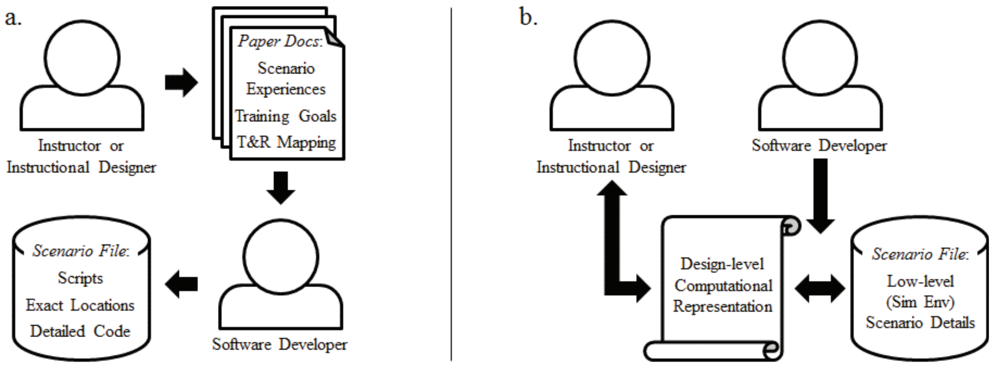

Fig.1. Simulation-based training “scenarios” (a) usually focus on specifying the scripted mechanics of a training situation. A design-level computational representation (b) would enable greater flexibility and tailorability of training scenarios.

3. Goals and requirements

We aim to imbue the simulation-based training environment with tools and frameworks that give instructors the flexibility and adaptability they enjoy in live training environments, as envisioned in Figure 1b. As opposed to Figure 1a, instructional designers and developers do not create training events without knowledge of the underlying simulation. Instead, they manipulate a new computational representation that explicitly captures scenario content, training goals, and the rationales that map events to goals. Further, the scenario description process automatically generates (compiles) the simulation’s “scenario file” and makes the low-level constraints that impact design evident to the instructional designer. Because the instructor works at the design level rather than with the specific details of the simulation environment, significantly less technical skill is needed.

A computer-interpretable language is needed to represent the design of training scenarios and instructors and instructionaldesigners need to be able to express their designs in this language. These requirements impact the level of abstraction that the representation language should target, as discussed further below.

Table 2.Simulation-based training scenarios are more rigid than live training scenarios.

Characteristics	Live Training	Simulation-based Training
Developer	Instructional designers and instructors frame live training events. Instructors can adapt on the fly during execution, giving them a role in the training development process.	Instructional designers and developers create a training experience. Often developers implement with little feedback from designers.
Media	Text and pictures are used to convey the training goals and the context in which those goals are to be pursued.	Computer files can be read by the simulation. The files may or may not be supplemented with training context.
Training Goals	Training goals are captured in the documentation of the training event.	Training goals are not usually represented directly in the simulation computer files. A human-readable mapping from a file to some T&R goals is often documented.
Rationales	Rationales are often captured in the documentation of the training event.	Rationales are usually captured in the documentation of the design. These documents may be missing or not updated to reflect the actually implemented scenario.
Operational Tailorability to Trainees	Instructors can direct role players and event referees to tailor the training event as it develops.	In most cases, the instructor’s ability to tailor training to individual trainees requires programmingskills. There may be a facility to choose pre-defined paths during execution.
Extensibility of Curriculum	Instructors are free to modify and adapt the scenario over time to reflect what works or changing content.	In most cases, the instructor’s ability to modify the scenario implementation requires technical skills.

3.1. Computational narratives within training simulation

Narrative refers to the presentation of a coherent sequence of events that combine to tell a story. Narrative framing is often used in training systems to provide context for practice and to introduce persistence across training events. A good example of a cross-cultural training system that used this kind of framing is ELECT BiLAT, a cross-

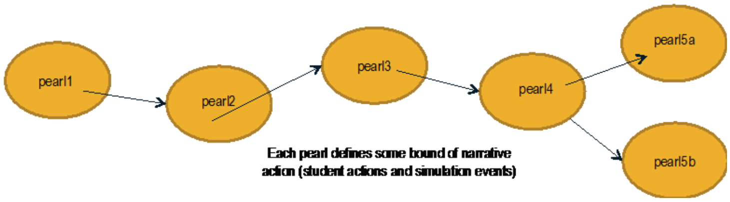

Fig.2. Computational narrative codifies event bounds within training simulation.

cultural, bi-lateral negotiation practice environment [1]. BiLAT is situated in a town and the trainee meets with multiple town members. The overall narrative framing includes backstories for the characters and allusions to theirpast interactions and relationships. Creative writers, training designers, and software developers constructed the narrative in BiLAT. The designspecifiesall possible NPC responses to each player utterance [11].

Today, machine-interpretable representation languages are allowing game developers and training designers to push some of the implementation of narrative details to the computer. Computational narrative [10] provides a mechanism for a computer to construct a narrative sequence of events. In a computer game, computational narrative can be used to identify irrecoverable actions that a player might take that would stymie further progression of the story in order to pro-actively circumvent such action [12]. It can identify internal goals for a non-player character that satisfy narrative requirements [13]. Computational narrative tools are also used in learning and training to categorize and choose alternative “paths” in the training scenario that address the observed learning needs [14, 15].

We are using computational narrative for this latter purpose. Given the representation oftraining scenario, a tailoring system [8] is able to evaluate and choose among the alternatives defined within the representation.Consider the schematic illustration in Figure 2.A training scenario is designed to progress through a series of events. In today’s simulation-based training, these events are points in the narrative space; they are exactly defined. A specific event or action will happen at a defined time or in response to a defined trainee action. In contrast, the narrative representation allows these events to be more loosely defined in advance. Each *pearl* bounds narrative action; rough synonyms include *beats*[16] or a *scene* or *vignette*. The motivating concept is that there is some allowed/acceptable variation that occurs within the scene but the transition from pearl to pearl is more fully defined. There can be branching from a scene to different alternative scenes as well, but, for us, most of the variation occurs within a scene. This approach is thus much more limited in scope than developing a coherent narrative framing across training scenarios (as in ELECT BiLAT example). However, computational narrative provides a path for such narrative framing across training scenarios in the future.

The role of narrative representation can be considered by comparison to an approach that focuses on individual, agent-based intelligence to control characters. In the past, we have created cities of individual characters that each move according to their own intelligence. This, of course, reflects how a city full of real people live together. Using intelligent agents, we have created training scenarios with many thousands of individuals simulating daily life. However, we learned that this approach does not meet the needs of many training simulations because it is difficult to design and to control the presentation of specific events and event details. Without an explicit representation of the desired outcomes, a desirable training outcome can be produced but it necessarily includes the possibility of missing a training opportunity because emergent behavior did not happen to align as needed. The requirement for training is much more like that a film, which may present a representation of reality butwas constructed from directly controlling actors and extras on a set.

3.2. Instructor-mediated design and control

Computational narrative tools can support the open-ended generation of narratives. However, we seek to determinean effective level of abstraction and specification of the narrative representation language, given competing constraints in the use of the language for training. Instructors and other end users need to be able to understand, control, and modify the system. Such*instructor-mediated design* is critical for increasing end user acceptance and effectiveness using new technologies [17, 18]. This design approach emphasizes direct user control without requiring detailedtechnical knowledge.As a result, weconstrain the control available in a tool in a user-

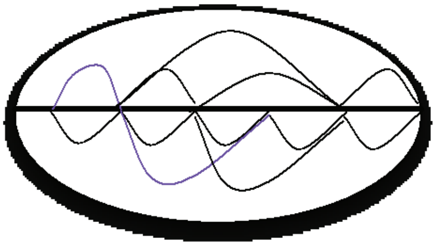

Fig.3. Branches (“arcs”) resolve to the baseline narrative.

centric way. We retain control necessary for end users to express their individual instructionalpreferences, but without exposing complex details that require technical staff to configure.

There is a tradeoff between increased expressive power and increased technical requirements imposed on content authors. For the first iteration of the computational narrative implementation, we chose a highly restricted language. This language allows no branching between pearls and all the branches within the pearl must resolve back to the base narrative. These limited branches (*arcs*) allow some variation in system response but because the options resolve back to the mainline, the scenario author does not need to maintain and develop many different narrative branches. As we discuss further below, these restrictions were apt in the specific domain in which we are currently working but are not likely to be apt for many other training domains. However, our aim was to privilege instructor-mediated design over other objectives initially. Over time, we will increase the expressivity of the language while attempting to maintain its authorability and the understandability of resulting narrative options.

4. A narrative representation for perceptual training

The Virtual Observation Suite – Demonstrator (VOSD; formerly called VOP) [3] is an immersive virtual environment wherein trainees can practice and demonstrate perceptual and cognitive skills. VOSD targets distal, sustained observation of people and the places people frequent, to wit, simulated characters move and interact during daily life in a simulated town. Trainees make sense of the simulated behaviors they observe by inferring the reasons underlying them, to develop a sense of cultural and behavioral baseline in an area, recognize and interpret behavior anomalies, and communicate their observations.

Computer-controlled characters in the VOSD play out individual and interacting scenes. Furthermore, the training experience can be tailored in real time to support or challenge individual trainees. Examples of tailoring include making event durations shorter or longer to manipulate trainee reaction time, changing event locations to make them more obscure or apparent, and changing the numbers of simulated characters participating in events.

The training and tailoring capabilities of the VOSD helped dictate what the training system should be able to represent about scenario narrative. The narrative representation includes explicit segmentation of training into events, training goals (task, performance standards, and relevant conditions) that differentiate available events, and expected learning impact of different events or support. This information enables automated narrative tailoring that works to bring about conditions, contexts, and cues that enable effective training for each individual.

As an example, a trainee might be required to observe that two important persons in the local community are meeting one other in a market. The trainee should visually acquire the characters as the meeting begins, remember that the characters are locally important, judge that their meeting is valuable knowledge, and report the meeting with a clear communication. The trainee’s performance of these tasks can be consistent with or deviate from standards and expectations. The trainee could notice the meeting right away, after some time, or even anticipate their meeting as the characters approach oneanother. Cues and trainee performance can occur under different conditions – in broad daylight, in a crowded marketplace, or even out of direct sight. The narrative representation enables the tailoring system to reason about training goals associated with different available events that depict the meeting.

Continuing the example, the tailoring system might choose to have the two characters walk towards each other in daylight on a city street that the trainee is able toobserve. The narrative representation would encode the expectation that the trainee will see the characters within some short period of time (e.g., 30sec). If the trainee does not observe the characters in that time, this provides evidence about his visual scan skills but also may interfere with later correct performance. In this case the narrative representation includes many optional events to provide opportunities to tailor the visual salience of the target characters to respond to the missed observation: a group of noisily playing children draws the trainee toward the target individual. Perceptual sensorsrelate the trainee has dwelled on the character for sufficient time to infer he has been seen.

The narrative representation also encodes the expected impact of events in supporting or challenging trainees. For example, had the tailoring system formed a goal to challenge task performance, it could have deployed the playing children event in a different location to distract the trainee. Representing these options explicitly lets the tailoring system arrange how it composes individual events to present a cohesive and consistent training scenario. As the meeting continues, the tailoring system can add support or challenge via interjections over a radio from a “virtual” observation team. In order to make the meeting easier to observe and focus this trainee on the task of interpreting its importance, the tailoring system can change the place where the two characters meet each other and increase the magnitude of their physical gestures during their conversation. These changes are associated in the narrative representation with different training goals and needs of individual trainee types.

Finally, the narrative representation captures performance standards by representing expected trainee responses to cues and conditions. Under the current circumstances and support interventions, the narrative representation might state that the trainee should report observing the meeting within one minute for expert proficiency or within three minutes for a novice in the relevant skills. Then as the actual time that the trainee goes without reporting extends, the tailoring system knows how to interpret this as evidence about underlying skill proficiency. At the same time, the narrative representation also describes how to react to different evidence. For example, truncating the meeting duration might be appropriate if a trainee responds early, while appending a new event where the characters walk together past the trainee might be appropriate for a trainee who is struggling. These can be chosen in real time because the narrative representation defines training goals for each component event of a scenario narrative.Thus having represented training goals within the narrative, the real-time system can choose an appropriate path in the tailoring space that highlights or augments training objectives.

5. Summary and conclusions

In this paper, we have introduced the use of computational narrative representation with the goal of making simulation-based training scenarios more flexible and adaptable to both individual trainees and for instructor customization and manipulation. Our computational narrative representation is relatively limited in scope and expressiveness because we seek to ensure that instructors can understand and control dynamic trajectories of trainees in simulation and be able to recognize and to explain simulation outcomes to trainees in after action review. Although the initial implementation is modest in its expressivity,the success in our use of computational narrative to support simulation-based scenarios suggests we have completed an initial step toward achieving the flexibility and adaptability of live training scenarios.In terms of immediate next steps, we plan to:

1. *Incorporate event semantics:*Today, human-understandable labels represent alternate events but the labels are not meaningful to the machine. Additional data (such as the learning objective and the author’s sense of the instructional properties of the action) is used to choose action alternatives [8]. We plan to incorporate machine-interpretable descriptions of the event itself, drawing on event ontologies, to allow the machine greater flexibility in choosing (and, eventually, composing) tailoring alternatives. Improved semantics are also likely to help instructors understand and control the learning trajectory as well.
2. *Branching within pearls:* Branching is constrained within pearls primarily because of the difficulty of ensuring cohesive threads in a highly scripted control environment. For example, increasing the duration of an event (such as the two characters converging on the meeting location) requires not only changing the paths and speeds of these two characters, but all other characters (“the pattern of life”) within the town because the behaviors of these entities are scripted and not dependent or sensitive to the actions of other entities. Improving the behavioral capabilities of entities in the simulation both enable more complex branching and simplify authoring within pearls.

3. *Narrative repair:* Despite good design and targeted guidance, sometimes learners will violate the constraints of a learning experience, resulting in a situation outside the bounds of the current pearl. We are investigating methods that would allow the tailoring system to “repair” the pearl by the execution of some simulation events, ideally events that are within the overall narrative framework. For example, instead of resetting or quitting a scenario once a boundary is violated, a virtual “Sarge” might radio to the trainee to fill in missed gaps and direct the trainee to look for key upcoming events. Performing narrative repair in a tractable way requires the event ontology so that the system (rather than author) can construct a path “back to the story” without requiring many possible excursions be anticipated in advance.

Longer-term, computational narrative offers the opportunity to increase engagement (e.g., generating a cohesive flow from one training scenario to another), improve ecological validity (more closely resemble and reflect real-world requirements), and to facilitate transfer of learned skills to those real-world settings.

Acknowledgements

This work is supported in part by Office of Naval Research (ONR) contract N00014-11-C-0193. The views and conclusions contained in this document are those of the authors and should not be interpreted as representing the official policies, either expressed or implied, of ONR or the US Government. The US Government is authorized to reproduce and distribute reprints for Government purposes notwithstanding any copyright notation hereon. We would like to thank ClarissaGraffeo and Joy Martinez at DSCI MESH who have led scenario design in the VOSD.

References

[1]J. Kim, R. W. Hill, P. Durlach, H. C. Lane, E. Forbell, M. Core, et al., "BiLAT: A game-based environment for practicing negotiation in a cultural context.," International Journal of Artificial Intelligence in Education, vol. 19, pp. 289-308, 2009.
[2]H. C. Lane and R. E. Wray, "Individualized Cultural and Social Skills Learning with Virtual Humans," in Adaptive Technologies for Training and Education, P. J. Durlach and A. M. Lesgold, Eds., ed New York: Cambridge University Press, 2012, pp. 204-221.
[3]S. Schatz, R. Wray, J. T. Folsom-Kovarik, and D. Nicholson, "Adaptive Perceptual Training in a Virtual Environment," presented at the Human Factors and Ergonomic Systems (HFES-2012), Boston, 2012.
[4]S. Schatz, C. Oakes, J. T. Folsom-Kovarik, and R. Dolletski-Lazar, "ITS + SBT: A Review of Operational Situated Tutors," Military Psychology, special issue on current trends in adaptive training for military ap-plication, 2012.
[5]R. E. Clark, "Learning from serious games? Arguments, evidence and research suggestions.," Educational Technology, vol. May-June, pp. 56-59, 2007.
[6]P. J. Durlach and A. M. Lesgold, Eds., Adaptive Technologies for Training and Education. New York: Cambridge, 2012, p.^pp. Pages.
[7]J. Cohn, "Building Virtual Environment Training Systems for Success," in The PSI Handbook of Virtual Environments for Training and Education. vol. 3, J. Cohn, D. Nicholson, and D. Schmorrow, Eds., ed Westport, CT: Praeger Security International, 2008.
[8]R. E. Wray and A. Woods, "A Cognitive Systems Approach to Tailoring Learner Practice," in Proceedings of the Second Advances in Cognitive Systems Conference, J. Laird and M. Klenk, Eds., ed Baltimore, MD, 2013.
[9]S. Schatz, E. A. Reitz, D. Nicholson, and D. Fautua, "Expanding Combat Hunter: The science and metrics of Border Hunter," in Interservice/Industry Training, Simulation & Education Conference (I/ITSEC), Orlando, FL, 2010.
[10]C. Graffeo, T. S. Benoit, R. E. Wray, and J. T. Folsom-Kovarik, "Creating a Scenario Design Workflow for Dynamically Tailored Training in Socio-Cultural Perception," in Proceedings of the 2015 Cross-Cultural Decision Making Conference, ed Las Vegas: Springer-Verlag, 2015.
[11]R. W. Hill, J. Belanich, H. C. Lane, M. Core, M. Dixon, E. Forbell, et al., "Pedagogically structured game-based training: Development of the ELECT BiLAT simulation," in Army Science Conference, Orlando, 2006.
[12]B. Magerko, "Evaluating Preemptive Story Direction in the Interactive Drama Architecture," Journal of Game Development, vol. 3, 2007.
[13]R. M. Young, M. O. Riedl, M. Branly, A. Jhala, R. J. Martin, and C. J. Saretto, "An architecture for integrating plan-based behavior generation with interactive game environments," Journal of Game Development, vol. 1, 2004.
[14]M. O. Riedl, A. Stern, R. Dinini, and J. Alderman, "Dynamic experience management in virtual worlds for entertainment, education, and training," International Transactions on Systems Science and Applications, Special Issue on Agent Based Systems for Human Learning, vol. 4, pp. 23-42, 2008.
[15]B. Magerko, R. Wray, L. S. Holt, and B. Stensrud, "Customizing interactive training through individualized content and increased engagement," in Interservice/Industry Training, Simulation and Education Conference (I/ITSEC), Orlando, 2005.
[16]R. McKee, Story: Substance, Structure, Style and the Principles of Screenwriting: ReganBooks, 1997.
[17]A. Woods, B. Stensrud, R. E. Wray, J. Haley, and R. M. Jones, "A Constraint-Based Expert Modeling Approach for Ill-Defined Tutoring Domains," in Proceedings of the Florida Artificial Intelligence Research Society (FLAIRS) Conference, ed Hollywood, FL: AAAI Press, 2015.
[18]J. T. Folsom-Kovarik, R. E. Wray, and L. Hamel, "Adaptive Assessment in an Instructor-Mediated System," presented at the Artificial Intelligence in Education (AIED), Memphis, 2013.