Pedagogical Experience Manipulation for Cultural Learning

Robert WRAY [b], H. Chad LANE[a,1],
Brian STENSRUD [b], Mark CORE[a], and Laura HAMEL [b] and Eric FORBELL [a]

[a] *Institute for Creative Technologies, University of Southern California, USA*
[b] *Soar Technology, Ann Arbor, MI, USA*

Abstract. Acquiring intercultural competence is challenging. Although intelligent learning environments developed to enhance cultural learning can be effective, there is limited evidence regarding how best to dynamically manipulate these environments in support of learning. Further, the space of potential manipulations is extremely large and sometimes tangled with the implementation details of particular learning systems in particular domains. This paper offers a framework for organizing approaches to such *dynamic tailoring* of the learning experience. The framework is hypothesized to be useful as a general tool for the community to organize and present alternative approaches to tailoring. To highlight the use of the framework, we examine one potential tailoring option in detail in the context of an existing simulation for learning intercultural competence.

Keywords. Pedagogical experience manipulation, dynamic tailoring, intercultural competence

Introduction

The National Academy of Engineering has identified "personalized learning" and "advancing virtual reality" as grand challenges for the new millennium [1]. Models of human social and cognitive behaviors are enabling simulations to provide practice opportunities in soft-skill and interpersonal domains, including cultural awareness [2,3] among many others. Some simulations have attempted to adapt to individual learner needs by tracking learning and presenting scenarios of appropriate difficulty. However, little has been done to manipulate character behaviors and environmental events dynamically, in a fine-grained way, with the goal of promoting learning. In this paper, we report on a work-in-progress prototype that seeks to promote cultural learning via tailoring of on-going dialogues of virtual human characters in a game-based learning environment, which provides more direct individualization and personalization as envisioned by NAE.

The technical approach falls into the broad category of *experience manipulation*, which we define simply as adjustment of the usual behavior of simulation elements to achieve an objective. If we assume that the goal of a simulation is to behave in the most realistic way possible (i.e., fidelity is the most important dimension), then a decision to

[1] Corresponding Author: H. Chad Lane, USC Institute for Creative Technologies, 13274 Fiji Way, Marina del Rey, CA 90292 USA, email: lane@ict.usc.edu

manipulate the experience means that a goal other than fidelity has been given higher priority. Examples of experience manipulation are evident in commercial video games where entertainment value trumps realism. For example, a popular golf video game will sometimes produce the sound of an explosion as the ball comes into contact with the club. Although the player receives the realist*ic feedback* from the simulation for hitting a good shot (e.g., that the ball traveled 320 yards), the additional “explosion” feedback is believed, at least by the game designers, to enhance the experience.

We are particularly interested in the use of experience manipulation to further and to achieve pedagogical goals. Such *pedagogical experience manipulation* [4] concerns how one can intrinsically adjust a learning environment and simulation to promote learning. We assume pedagogical experience manipulation will generally be used in tandem with extrinsic learner supports (i.e., those which come from “outside” the simulation), such as instructional components and intelligent tutoring.

There are at least two opportunities for an intelligent system to adjust simulation behaviors in order to promote learning (see **Table 1**). The first concerns “configuration” where the system selects or generates situations/scenarios that are appropriate for a learner at any given time. The second category of experience manipulation, and one explored in this paper, is *dynamically tailoring.* We define dynamic tailoring as a process that continuously adapts the environment and simulation to meet the needs of a learner through his or her interactions with an on-going learning scenario.

As suggested by the table, manipulations for both configuration and dynamic tailoring can be conceived to address the affective states of the learner, as well as direct domain learning. While, as we highlight later, dynamic tailoring could have a clear role for maintaining or improving learner motivation, in this paper, we primarily focus on tailoring for domain learning, with intercultural communication the primary domain.

Table 1: Dimensions of pedagogical experience manipulation

	engagement/affect	domain learning
configuration	*provide experiences that motivate & encourage*	*provide experiences that address specific learner needs*
dynamic tailoring	*adjust simulation behaviors to motivate & encourage*	*adjust simulation behaviors to address specific learner needs*

Dynamic tailoring comprises not only more familiar methods of directly supporting learning objectives, but also emerging methods that employ narrative adaptation and user-interface manipulations [5-7] to engage and motivate. This paper presents a framework that organizes a design space including all of these different potential tailoring elements, aids design-time evaluation of options, and, long-term, enables rigorous comparison and empirical evaluation of the impacts of different tailoring approaches on learning.

1. Cultural and social learning with virtual humans

1.1. Acquiring cultural knowledge

Learning and adapting to a new culture is a significant challenge. In different cultural contexts, interpersonal and communicative behaviors that seem natural may produce unexpected results. For example, simple habits such as nodding and other forms of backchannel feedback can lead to unintended agreements that may, in turn, negatively affect trust, reputation, and so on. Although it is generally agreed that it takes years of first-hand experience to fully acclimate (i.e., living in-country), it is certainly important for someone who will be spending time in a new cultural context to prepare. This is the problem cultural training programs attempt to solve.

To develop intercultural competence in a general way, training should be built around identifiable stages of development [8]. For example, if one is rushed to the point of behavior adjustment with limited or no understanding of the underlying cultural reasons behind observed behaviors, it could greatly hinder their overall development. Also, it is common for intercultural training programs to build off the notion of cultural difference [8] and support learners through *perspective taking* exercises [9]. Intercultural communication is a common focus of such approaches since face-to-face contact is so prominent. Our work is focused on teaching intercultural communication skills and our aim is to enhance a learner's ability to identify cultural differences, understand the underlying cultural concepts, and practice communicative strategies in a computer-based learning environment.

1.2. The Cultural Meeting Trainer

The Cultural Meeting Trainer (CMT) is a simplified and scaled-down version of the ELECT BiLAT system, developed at the Institute for Creative Technologies with the support of their U.S. Army partners [10]. BiLAT is an immersive, virtual learning environment that teaches intercultural negotiation skills. It includes instructional materials as well as a virtual practice environment for conducting background research, preparation for business meetings, simulation of social and business interactions with virtual counterparts, and an after-action review.

The CMT focuses primarily on the cultural aspects of "small talk" and trust-building that occur during social periods of meetings. Using the BiLAT game mechanics and scenario data, the CMT enables interactions between a player/trainee and several different simulated Iraqi non-player-characters (NPCs). The goal of each interaction is to "chat" with an individual Iraqi and gain his/her trust sufficiently to move into a formal negotiation.

Importantly, the CMT is focused on supporting research and experimentation. For example, ELECT BiLAT represents the domain in a 3D virtual environment; the CMT uses much simpler simulation technology (Flash, still images). The simpler world representation and web-based interfaces make it a more portable and lightweight system for implementing and evaluating different tailoring options. Because CMT presently incorporates ELECT BiLAT's learning objectives and supporting content related to intercultural competence, evaluation results should be translatable to BiLAT (as long as the results are not dependent on the lack of immersion in CMT). It may even be possible to fold effective tailoring options into the BiLAT system as they are identified and refined in the CMT.

2. Organizing the Design Space for Tailoring: A Framework

One of the motivations for the research we are pursuing is that while ELECT BiLAT includes instructional support and an intelligent tutor that offers feedback, guidance, and hints, a number of opportunities exist to further enhance the system's ability to convey the cultural knowledge it seeks to teach. This observation raises the questions of what kinds of pedagogical experience manipulations are feasible and worthwhile in a domain such as intercultural communication. Although CMT is a relatively simple environment (in comparison to ELECT BiLAT), the number of possible interventions is still very large. In order to understand the options and prioritize them, we have developed a framework that organizes the design space for tailoring. The framework enumerates the general reasons one might use tailoring strategies and the classes of tailoring strategies one might use in simulation- or game-based learning environments.

The framework is designed to be general enough to describe potential interventions across a wide-range of domains. It is not intended to be specific to the CMT or to the domain of cultural learning. Others should be able to use the framework to organize and situate their own tailoring research and extend and adapt the framework to their needs. For example, this framework could be combined with an ontology of cultural learning [11] to connect inter-cultural learning objectives to specific tailoring strategies. Further, our hypothesis is that this framework will facilitate the separation of evaluations of tailoring manipulations from evaluations of specific learning environments offered for particular domains. For example, one might ask about the relative effectiveness of tailoring via manipulating character utterances vs. highlighting options as a scaffolding strategy, or compare the impact of outcome manipulation across different purposes, timings, and frequencies independently of the domains in which these strategies were implemented.

The following subsections describe the current framework, using examples from CMT to highlight potential design options. To be explicit, we have not implemented (nor intend to implement) all of these strategies and approaches outlined here. The current purpose in this section is to begin to suggest the large design space of potentially effective tailoring options and the way in which we have organized the space to inform implementation choices.

2.1. Purposes of tailoring

Dynamic tailoring can be employed for five functional purposes:

Scaffolding is the process of adapting practice-environment content to support learning and practice directly, via supports that enhance the development of conceptual or skill knowledge, especially for novice or struggling students [12, 13]. Scaffolding enables the system to manipulate the practice context to directly support observed deficits in student knowledge/learning. For example, a tailoring scaffold might be to elaborate an utterance by an NPC in response to incorrect action with an explicitly guiding phrase ("Please do not show me pictures of your wife; this is not appropriate in my culture.")

Fading: Scaffolding is often accompanied by processes that allow “fading,” the gradual removal of scaffolds that are no longer necessary as students move to higher levels in terms of the zone of proximal development within the learning space [14]. With respect to dynamic tailoring, fading strategies are ones that gradually remove scaffolds as the student demonstrates increasing skill. For example, if there was a scaffolding strategy to only offer task-salient options to a novice trainee, a fading strategy for tailoring might be to increase the number of available options, including distracters, with increasing skill.

Challenging: Challenges are dynamic content adaptations that make fine-grained, turn-by-turn components of practice more difficult. They can be used to exercise specific skills of the learner and keep him or her engaged and in the zone of proximal development [15]. Challenges include manipulations that increase complexity or difficulty, either for progression to higher levels or for assessment (e.g., "is the student now capable of handling this situation?"). In the context of dynamic tailoring for cultural training, challenging is assumed to be a decision that can be made for specific interactions in a dialog (a touchy subject or surprising reaction) rather than at the scenario level (a difficult character) and that can be customized and adapted to specific learning objectives. An example of the latter option might be providing a student with little direct feedback in response to a provocative question, leaving it to the student to decide whether or not the question was appropriate.

Scaffolding, fading and challenging all involve manipulation of the level of difficulty perceived by the student. However, they can be distinct processes. In cultural training for example, challenging could mean manipulating character responses to be more negative. However, if student performance decreases, scaffolding could be used to increase the pedagogical content of character responses (i.e., the character explains the rationale for their negative reactions). If student performance improves, fading would decrease the pedagogical content of character responses, removing the scaffolding.

Engaging: Student errors may derive not only from a lack of knowledge or expertise but also from issues related to attention, stress, and motivation. These demands are especially important for cultural training, as part of the goal of the practice environment should be to cause (manageable) overloads on attention and stress to attempt to suggest the real-world conditions for interaction. Psychophysiological sensors, such as EEG, galvanic-skin response (GSR), and even eye tracking can provide insights into cognitive state to enhance diagnostics and enable better tailoring [16]. Adaptations can be prescribed that are designed to address errors or test student skill in response to observations of cognitive state. Thus, adaptations may include both scaffolding adaptations (e.g., when a novice student was observed making errors under high stress, the system could introduce an event that reduced complexity). Others may be geared more toward directly engaging the learner in the content (e.g., narrative adaptations). An example might be forcing a strong reaction from a character in an on-going conversation when attention to the conversation was observed to be lagging.

Individualizing: Trainees with motivations, mindsets, or technical illiteracies that do not match the simulation experience may not engage or learn as well as those who do enjoy / learn well from the experience [17]. To improve the effectiveness of a practice environment and better reflect the preferences of a diverse population of trainees, practice environments also need to adapt how the simulation actually works to the learner. An example might be removing time pressure for a learner who is internally motivated and thus likely prefers a more exploratory (test-evaluate) learning process.

2.2. Classes of tailoring actions

Regardless of the purpose of the tailoring manipulation, another key dimension influencing the potential role of tailoring is to consider the ways in which any kind of tailoring could be accomplished. For current simulation- and game-based learning environments, tailoring manipulations can be grouped into five categories.

Outcome manipulation: The effects of the student's action are modified by the tailoring system. For example, a scaffolding outcome manipulation strategy might be to dampen the negative effects of errors when the student is a novice. Such a strategy may reduce frustration and provide some sense of accomplishment for the novice learner.

Character utterance or gesture: A character generates some communicative performative, mediated by tailoring. Tailored utterances can be made in response to a student action or can also be anticipatory, providing context or even guidance for some upcoming student decision. The responses generated by the character can be spoken (including textual output) and also indirect (via gesture). Character response is a subcategory of outcome manipulation but we bring it out as a distinct class for two reasons. First, face-to-face interaction is particularly important in the CMT domain and most of the feedback a player receives will come thru other characters. Second, in current simulation environments, there is typically a strong encapsulation of the implementation of character behaviors and other events in the simulation at the implementation level. Thus, the implementation of any tailoring strategies for utterances would likely differ substantially from more general outcome manipulations.

Player choice manipulation: Another way to tailor experience is to manipulate the options and actions available to a character. Such manipulations would include direct modifications of the actions available to the student at any one time. For example, in a simulation (like CMT) where actions are chosen via menu, a scaffolding strategy might be to highlight or filter the actions that are salient in the current situation. (Such moding may work well in menu-based environments, but have limited applicability elsewhere.) Player choice manipulations could also include narrative-style adaptations, where routes of exploration are blocked or objects in the environment are not fully functional until some learning or experiential objectives are met.

Simulation/Event manipulation: Experience can also be tailored by dynamically adapting the situation to which a student is presented. This category is similar to outcome manipulation, with the distinction that the event manipulation need not be made in direct response to a student action. In general, this class includes any non-reactive event introduced to support pedagogy rather than realism. For example, one could introduce biases that decreased complexity and vicissitude in character interactions for novice students and biases to increase complexity and unpredictability in those interactions as the core concepts of interaction are mastered. Other examples would be to introduce environment events that reinforced pedagogical feedback or to bring the learner’s attention to the environment.

Gameplay manipulation: Tailoring may also include manipulations that change the way the simulation is experienced. Examples might include adding or removing an explicit representation of the progress and status, depending on the learner’s source(s) of motivation, enabling access to external (non-game) content to amplify or aid the pursuit of learning objectives, and changing the interface of the game to accommodate the preferences and technical literacy of individual learners.

Table 2 introduces general example(s) for each class of action and then provides a specific example(s) of these manipulations in CMT. The purpose motivating each tailoring strategy is highlighted in bold.

Table 2: Examples of different types of tailoring actions available in simulated environments.

	Example Tailoring Strategy	**CMT Example**
Outcome manipulation	Early incorrect actions can make progress difficult & frustrating. A tailoring **scaffold** can reduce the negative impact of incorrect actions so it is possible for novices to advance in a scenario.	When a player jumps immediately to business after introductions, the normal negative effect of this "brash" action is dampened, roughly simulating that this character "knows" how Americans typically approach business.
Character utterance	A tailoring **scaffold** results in a character providing direct guidance about a learning objective in its response.	In response to the player showing a picture of his wife, the character is directed to say: "Showing such pictures is not a good thing to do in my culture."
Character gesture	Tailoring can **scaffold** or **fade with** facial expressions and body language to accompany character speech.	When a novice student shows an inappropriate picture, the character displays a look of surprise or disgust, in order to amplify any uttered response.
Input manipulation	Tailoring can **scaffold** actions via filtering inappropriate or highlighting appropriate actions, **fade,** by changing when filtering/highlighting occurs and its extent, and **challenge** by introducing "distracter" actions.	To **challenge** a student who previously talked to a character who was a soccer fan, the student is presented with a "talk about soccer" action option when meeting with a character for whom there is no prior evidence indicating an interest in soccer.
Event manipulation	Tailoring injects "interruption" events to **challenge** or **engage**. Events are appropriate for a one-on-one meeting and may be used to cue meeting transitions.	To **engage** a student who is not attending to the simulation, tailoring introduces an "over the top" reaction, perhaps emphasizing the busyness of the character and the need to make better progress.

3. Exploring Tailored Character Utterances in CMT

As suggested above, in the "small talk" domain of the CMT, the majority of feedback within the simulation experience itself comes from the on-going conversation with other characters. The native character content provides up to twelve different possible responses to every player action or utterance. This approach provides a mechanism for the existing system to customize responses to the situation. For example, a player who has gained little trust with the character and makes a mistake may be presented with "harsh" feedback ("Do not bother me with your pointless apologies!"). However, when trust is greater, the character may be more accepting of the mistake and offer a response without a negative valence. These "polarities" in the responses could be rigorously mapped to theories of "positive" and "negative" face [18] but, in the present exploration, we have only annotated the responses in an informal way. Having many potential responses also increases variation, which in turn better supports replay. Replay is important for novices because, due to mistakes and missteps, multiple discussions with the same character may be required before gaining trust sufficient enough to conclude a business meeting successfully.

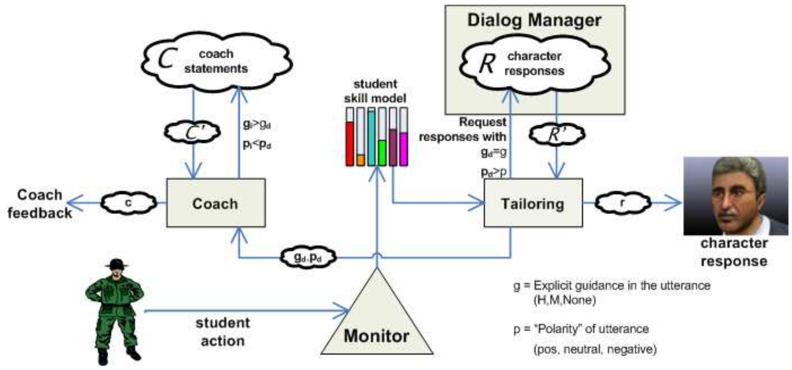

Figure 1: An approach to tailoring character utterances by annotation for polarity & pedagogical

In addition to having different "polarities," some character utterances also contain pedagogical guidance. For example, after the action of showing a picture of one's wife, which is generally inappropriate in Iraqi culture, the character can say, "She is pretty, but you should not show this picture to an Imam, I think." This kind of statement is supportive of the student in terms of affect (it is warm) but also points out the mistake in a constructive way that brings to mind the learning objective that has been violated.

In the current system, the choice of utterance is made via a function that depends on the level of trust, a set of intrinsic character traits (e.g. level of power, belief) and a random element. We are currently investigating a tailoring approach for character utterances that will allow the system to select utterances according to trust and the experience and skill of the student. Figure 1 illustrates the process. Our hypothesis is that biasing the choice of response in terms of a student's skill and experience will provide scaffolding for new learners and even experienced students encountering situations that cover new learning objectives. Further, this approach could possibly improve engagement in more experienced learners as more pedagogically-oriented content is filtered out for mastered learning objectives.

We have annotated all the character utterances in the system with tags indicating the polarity of the utterance (positive, neutral, negative) and the pedagogical guidance in the utterance (none, low, high). In our marking scheme, "high" pedagogical utterances must refer directly to a learning objective ("do not show pictures of your wife") while "low" pedagogical utterances may offer less specific feedback about the action ("You let your wife dress in this way? Your ways are clearly not ours.").

Whenever a student selects an action, a "monitor" process now tracks student progress and skill against specific learning objectives through the use of an expert model. The goal is to contextualize the student action in terms of the student's experience in the domain and their level of skill. Depending on these factors, a tailoring process chooses the level of guidance needed in the utterance and the desired level of polarity. The request can be for an utterance with a specific value or a range of values.

The dialogue manager provides the tailoring system with utterances meeting the constraints. The tailoring process then chooses an utterance which is generated by the system for the player to see. The tailoring process is also communicating its choices about the level of guidance and polarity it would like to use to a Coach [19] that provides explicit guidance and feedback. For example, if the tailoring process desired a high guidance option and the dialogue manager was not able to provide one, then the

Coach might decide to intervene and offer explicit feedback or a hint in the absence of the desired character utterance.

While the specific details of the tailoring process are still to be worked out, we are anticipating that for a novice student, new to the domain and the learning objective, the tailoring process might bias utterances toward positive polarity and high guidance, simulating a sort of "patient" character who easily forgives mistakes. As experience is gained in the domain, different characters would respond with more variability in polarity, even when offering high guidance for new learning objectives. As the student gains experience and skill, the tailoring process for pedagogical utterances plays less of a role, but may bias actions toward strongly negative polarity when the experienced student makes careless/thoughtless mistakes.

Simulation developers typically focus on realism in the dialogs, rather than utterances that are explicitly pedagogical. Thus, not surprisingly, there is a relative dearth of character utterances with "high" pedagogical content in the currently-authored dialogs. We are currently considering both re-authoring some of the existing dialogs, to include more pedagogical content and authoring "pedagogical elaborations" that would be added to the original utterances to bring out pedagogical content explicitly. Our initial review suggests that we will only need to author a few pedagogical elaborations for each set of character responses. This framework extends naturally to non-verbal actions (body language, facial expressions) associated with character responses. A minimally pedagogically informative response might have neutral language with the non-verbal action conveying the positive or negative reaction.

4. Conclusions

Simulation environments are useful tools for both the development of "soft skills" like intercultural competence and highly-proceduralized skills (e.g., flight control). However, practice is typically more effective when it is targeted to the learner's ability, needs, and motivations and accompanied by supportive guidance and feedback. In this paper, we have defined a framework for organizing and comparing different approaches to targeting practice via adaptive tailoring. We introduced tailoring both in the broad sense of its use in practice environments and described its potential role and application in a specific cultural training system.

Much remains to be accomplished in terms of exploring and evaluating the framework and the motivating hypothesis, especially in terms of measuring the effect of particular tailoring strategies on learning outcomes and user satisfaction. Also, in the case of simulations for learning, the question of fidelity is particularly important. Our long-term goal is to explore the hypothesis that pedagogical concerns should play a role in determining simulation behaviors. If a tailoring action produces a feasible and believable effect, *and is better for the learner*, then trumping the default behavior of the simulation engine seems reasonable.

We recognize the current framework is also incomplete; for example, it is not clear whether adaptations designed to prompt reflection on learning would be a distinct class of tailoring function or if this would be a category outside of framework (such as explicit tutoring). However, our intent is that the framework offers a way for researchers to organize, present, and discuss their approaches to tailoring independently of the specific domains in which they are working and the implementation details of their tailoring strategies. The framework may also prove beneficial in the design and implementation of game- and/or simulation-based learning systems to facilitate organization and prioritization of learner tailoring in these systems.

Acknowledgements

The work described in this paper was supported by the Air Force Research Laboratory, contract number FA8650-08-C-6837. We thank LT Sarah Fockel and Dr. Joseph Weeks for their support of this research, as well as Daniel Auerbach and Kelly Christoffersen for their support in the development of the CMT. BiLAT was sponsored by the U.S. Army Research, Development, and Engineering Command (RDECOM).

References

1. National Academy of Engineering, *Grand Challenges for Engineering*, V. Chase, Editor. 2008, National Academy of Sciences/National Academy of Engineering: Washington, DC.
2. Johnson, W.L., H. Vilhjalmsson, and S. Marsella. *Serious games for language learning: How much game, how much AI?* . in *12th International Conference on Artificial Intelligence in Education*. 2005. Amsterdam: IOS Press.
3. Kim, J., et al., *BiLAT: A game-based environment for practicing negotiation in a cultural context.* International Journal of Artificial Intelligence in Education, in press.
4. Lane, H.C. and W.L. Johnson, *Intelligent Tutoring and Pedagogical Experience Manipulation in Virtual Learning Environments*, in *The PSI Handbook of Virtual Environments for Training and Education*, J. Cohn, D. Nicholson, and D. Schmorrow, Editors. 2008, Praeger Security International: Westport, CT.
5. Magerko, B., B. Stensrud, and L.S. Holt. *Bringing the Schoolhouse Inside the Box - A Tool for Engaging, Individualized Training*. in *25th Army Science Conference*. 2006. Orlando, FL.
6. Mott, B.W. and J.C. Lester. *Narrative-centered tutorial planning for inquiry-based learning environments*. in *Proceedings of the 8th International Conference on Intelligent Tutoring Systems*. 2006.
7. Riedl, M.O., et al., *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, 2008. **4**(2): p. 23-42.
8. Bennett, M.J., *Towards ethnorelativism: A developmental model of intercultural sensitivity*, in *Education for the Intercultural Experience*, R.M. Paige, Editor. 1993, Intercultural Press: Yarmouth, ME. p. 21-71.
9. Kramsch, C. and R. Anderson, *Teaching Text and Context through Multimedia.* Language Learning & Technology, 1999. **2**(2): p. 31-42.
10. Hill, R.W., et al. *Pedagogically structured game-based training: Development of the ELECT BiLAT simulation*. in *Army Science Conference*. 2006. Orlando.
11. Blanchard, E.G. and R. Mizoguchi, *Designing Culturally-Aware Tutoring Systems: Towards an Upper Ontology of Culture*, in *Workshop on Culturally-Aware Tutoring Systems at the 9th International Conference on Intelligent Tutoring Systems*, E.G. Blanchard and D. Allard, Editors. 2008: Montreal. p. 23-34.
12. Davis, E. and N. Miyake, *Explorations of Scaffolding in Complex Classroom Systems.* The Journal of the Learning Sciences, 2004. **13**(3): p. 265-272.
13. Wood, D., J. Bruner, and G. Ross, *The role of tutoring in problem solving.* Journal of Child Psychology and Psychiatry and Allied Disciplines, 1976. **17**: p. 89-100.
14. Pea, R.D., *The social and technological dimensions of scaffolding and related theoretical concepts for learning, education, and human activity.* The Journal of the Learning Sciences, 2004. **13**(3): p. 423-451.
15. Vygotsky, L.S., *Mind and society: The development of higher psychological processes*. 1978, Cambridge, MA: Harvard University Press.
16. St. John, M., et al., *Overview of the DARPA Augmented Cognition technical integration experiment.* International Journal of Human-Computer Interaction, 2004. **17**: p. 131-149.
17. Coffield, F., et al., *Should we be using learning styles? What research has to say to practice*. 2004, Learning and Skills Research Centre: London.
18. Brown, P. and S.C. Levinson, *Politeness: Some universals in language usage*. 1987, Cambridge: Cambridge University Press.
19. Lane, H.C., et al. *Coaching Intercultural Communication in a Serious Game*. in *ICCE*. 2008.