Experience with Serious Games for Learning Foreign Languages and Cultures

W. Lewis Johnson, Ph.D., Ning Wang, and Shumin Wu

University of Southern California and Alelo, Inc.. *University of Southern California*

ljohnson@alelo.com *ShuminWu@isi.edu*

Abstract. The Tactical Language and Culture Training System (TLCTS) that is an interactive learning platform that helps people quickly acquire communication skills in foreign languages and cultures. It integrates serious game technology and intelligent tutoring system technology. Learners alternate between working on interactive lessons that teach communication skills and interactive games that require learners to apply those skills. TLCTS trainers have been developed for Arabic dialects and Pashto, and trainers for other languages are under development. Thousands of American service members have trained using TLCTS trainers. This paper summaries some of the lessons learned from putting TLCTS trainers into practice, both about serious game design in general and learning environment design for language and culture training in particular.

1. INTRODUCTION

The Tactical Language and Culture Training System (TLCTS) is an interactive learning platform that helps learners quickly acquire communication skills in foreign languages and cultures. It utilizes an integrated combination of intelligent tutoring system and serious game technologies. Trainees work through a series of interactive lessons and exercises, focusing on mission-oriented communication skills. The lessons make extensive use of automated speech recognition focused on learner language, and provide learners with feedback on their performance. Cultural notes describing customs and nonverbal gestures are integrated into the lessons. Trainees apply their skills in interactive games, which require knowledge of spoken language and culture in order to master.

Three TLCTS training courses have been developed so far: Tactical Levantine™, focusing on Levantine Arabic, Tactical Iraqi™, focusing on Iraqi Arabic, and Tactical Pashto™, focusing on the Pashto dialect spoken in southern Afghanistan. Tactical French courses are under development. These are complete training courses, providing all of the training materials needed to conduct basic training in foreign language and culture. For example, Tactical Iraqi™ includes eight Mission Game scenes, ten Arcade Game levels, and thirty-five Skill Builder scenes comprising over 1200 lesson pages. Additional scenes and lessons are under development. While the platform imposes no limit on content size, the material developed so far or these systems typically covers 80-120 hours of training. Web-based reference materials, including glossaries, summaries of lesson content, and grammar notes, are available both as part of the training package. Manuals, tutorials, training guidelines, and supplementary paper-based materials are also provided.

TLCTS is rapidly transitioning into widespread use. Computer labs for training with TLCTS courses have been established in a number of locations in the USA and around the world. Thousands of US military users have trained with the system, and consistently rate it highly. It will shortly be made available to service members in allied military forces, as well as the general public.

This paper gives an overview of TLCTS, and summarizes some of the lessons learned from the experience of putting TLCTS courses into practice. This experience challenges some of the common assumptions about the design of serious games for training in general, and the role of games in language learning software in particular.

2. SYSTEM OVERVIEW

Figure 1: Use of TLCTS

TLCTS runs on a videogame-capable personal computer, equipped with a noise-cancelling headset microphone and mouse. Figure 1 shows the system in typical use. The user navigates through the game using a combination of mouse movements and single-letter keyboard commands, as is typical with many PC-based videogames. The mouse is also used to control voice input in a push-to-talk fashion (click to start voice input, click to stop).

TLCTS courses focus on spoken communication skills, and the cultural knowledge necessary to deal with face-to-face encounters with people in a foreign culture. Most users to date are interested in acquiring basic functional communication skills quickly, and so the courses are designed to meet this need. Learners engage in spoken

interactions with the computer, e.g., speaking in response to spoken or displayed prompts. Trainees can engage in simulated dialogs with computer characters, at speeds approaching natural spoken dialog. TLCTS also has support for written language, in Arabic script and other non-Western fonts, so learners who have the time and inclination can also to learn to read the written language.

Trainees typically start training in the Skill Builder. The Skill Builder includes a set of learning modules, each typically focused on communicative skills appropriate to particular tasks or situations, such as such as Meeting Strangers, Introducing Your Team, or A Guest in an Arab Home. Each Skill Builder lesson includes example animated dialogs that illustrate the target communicative skills in action, lesson pages that introduce vocabulary, phrases, and cultural knowledge, and exercises and quizzes that reinforce those skills.

Figure 2 shows an example Skill Builder exercise page from Tactical Iraqi™. Here the learner practices giving responses to the spoken phrases. The learner clicks on a speaker icon to hear an Arabic phrase ("as-salaamu 'aleykum", meaning "Peace be upon you"), and then clicks on a microphone icon to respond (by saying "wa 'aleykum as-salaam", meaning "And upon you be peace"). The speech recognizer analyzes the learner's input, matches it against a set of possible correct and incorrect responses, and gives feedback accordingly.

Figure 2: Skill Builder page

Learners alternate between the Skill Builder and two game experiences, the Arcade Game and the Mission Game. The Arcade Game, depicted in Figure 3, is a casual game in which trainees can practice listening and speaking particular categories of words and phrases. In Figure 3, for example, the learner navigates through a game world, following directions given in Arabic, in order to locate targets and collect points. In speaking mode, the player uses spoken commands in the target language to direct his avatar through the game world. As the learner progresses to higher levels, enemies appear, which can be destroyed by speaking the corresponding word in the target language, e.g., a red enemy can be destroyed by saying "Hamra" (red). The Arcade Game requires no prior training to play, gives trainees practice speaking, and also introduces them to the game controls.

Figure 3: Arcade Game

Next, the trainees proceed to the Mission Game, where they use their communication skills to accomplish missions. Figure 4 shows a scene from the Mission Game in Tactical Pashto™. Here the player (foreground, left) is on a mission meet with the local leader to plan a reconstruction project. He is talking with some of the children in the village to get information about the town, and to establish rapport. He can communicate with the non-player characters via a combination of speech and gesture. To use a gesture, the player uses the mouse to select from a menu of possible gestures. In this example, the palm-over-heart gesture, common in the Muslim world, is chosen (depicted by the icon in the upper left). Then when the player speaks Pashto into the microphone, his avatar will automatically perform the gesture.

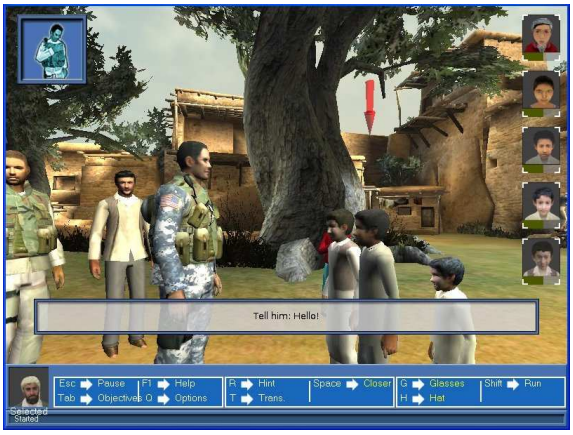

Figure 4: Mission Game

Trainees in the Mission Game must decide from moment to moment what to say, and the non-player characters are programmed to respond accordingly. If the trainee is uncertain of what to say, he or she can ask for a hint from his assistant, who is also a non-player character in the game. In Tactical Pashto™ the assistant takes the form of an Afghan go-between, shown behind the player in Figure 4. The presence of the assistant is intended to encourage trainees to start practicing in the Mission Game even when their communication skills are limited.

The Mission Game gives trainees the opportunity to practice their communication skills in the context of

realistic missions. These are based in part on the US Army's and Marine Corps' live simulation training exercises, where large numbers of Iraqis play roles in mock-up Iraqi towns. However, the level of difficulty and realism is carefully controlled. At the beginning level, the non-player characters are relatively tolerant of trainee mistakes; this helps trainees to build their confidence and overcome possible apprehension about trying to communicate in a foreign language. As trainees increase in experience, the reactions of the non-player characters become progressively more realistic. Another way in which training deviates from reality is that in TLCTS none of the characters speak English; this forces trainees to use the target language at all times. In other respects TLCTS training is more realistic than the training in live simulations. The virtual worlds more accurately reflect the environment in the foreign country than a mock-up town can. They can be populated with children as well as adults, whereas children are not permitted in live exercises due to child labour laws.

As trainees work with TLCTS, their performance is continually evaluated. Every time they correctly perform an action in an exercise that requires knowledge of a particular skill, this is used as probabilistic evidence that the trainee has mastered that skill. At any time the trainee can ask for a progress report that shows progress toward mastery of each skill. This provides useful feedback to trainees, keeps them focused on learning, and helps instructors to monitor trainee progress.

TLCTS is implemented as an application layer on top of a commercial game engine (Unreal Engine 2.5) and speech recognition package (Julius). The application layer generates the interface displays, controls the behaviour of the non-player characters, evaluates user inputs and generates responses, and evaluates trainee performance. The game engine has been modified to accommodate spoken input and to disable the shooting functions. Instead of shooting weapons, players must speak in the target language in order to accomplish their game objectives. Lesson content is specified in XML, created using collaborative authoring tools designed specifically for this purpose, and imported into the run-time system. This makes it relatively straightforward to retarget the platform to new languages and cultures.

The current version of TLCTS supports training on a single workstation. Training is typically conducted by individual trainees working at their own pace, although it can be even more effective for trainees to work in pairs, one speaking into the headset and the other conferring with the speaker about what to say and do. As the trainees progress through the system, the record of trainee progress can be automatically uploaded to a server in the training laboratory. This allows an instructor or lab manager to track the performance of each trainee.

3. ITERATIVE DESIGN AND EVALUATION

TLCTS was developed iteratively, through multiple cycles of development and evaluation [3]. Early, incomplete versions were tested with representative users, and feedback from these users helped to refine the system design and recommended program of instruction. This process has continued as TLCTS has transitioned into regular use.

The first prototype of the first TLCTS course, Tactical Levantine™, was delivered to the US Military Academy in the fall of 2003. This was intended as an illustration of the capability to be developed. A USMA cadet with knowledge of Arabic evaluated the prototype, and gave initial confirmation that the design showed promise. As the prototype was further developed, focused small-scale usability evaluations continued to be performed, following the "Guerrilla HCI" approach [5], as well as small-scale evaluations of user attitudes and learning outcomes [1].

In response to these initial evaluations, the design of the system evolved. One change was in the role of pronunciation error detection. For the early versions of the Skill Builder, we developed an advanced method for detecting pronunciation errors [4], and applied it thoroughly throughout the Skill Builder. Evaluations revealed that this had the unintended effect of causing learners to focus on pronunciation to the exclusion of more important skills such as rapid vocabulary recall and fluent speech production. Moreover the reliability of pronunciation error detection proved in practice to be inadequate at times. We therefore limited the amount of pronunciation feedback that the system provides, in most situations simply providing confirmation that the trainee's speech was intelligible, or providing feedback on language errors such as incorrect morphological endings or word choice. We continue to work on improved methods for analyzing pronunciation errors and providing feedback, but apply them in a limited focused fashion so that pronunciation skills do not take precedence over other important communication skills.

The overall architecture of the system also changed over the course of the iterative evaluations. One example of the change is the way that the lesson component and the game component of TLCTS are combined into a single system. In the first prototype the Mission Game and Skill Builder were separate applications. This proved to be burdensome from the user's perspective, because trainees wanted the freedom to switch easily between the Skill Builder and the Mission Game. Therefore a new implementation of the Skill Builder was developed, using the Unreal Engine as an interface front-end, and the original multi-process design was consolidated into two main processes, one handling the interface display and game engine, and the other handling voice input, non-player character control, learner tracking, and other functions [8]. This is an unusual application of game engine technology—game engines are not typically the first choice as platforms for multimedia learning environments. It ultimately required the development of an entirely new user interface on top of Unreal. Nevertheless it proved to be a practical approach, and the added utility from the user's perspective made the extra development effort worthwhile. We continue to work to

integrate and simplify the TLCTS architecture, so that training functions are accessible from a single application.

The first fully developed prototype TLCTS training system, Tactical Iraqi™, was completed in June 2005, and two-week extended trials with military trainees began immediately thereafter. Since then as US Army and Marine Corps users have made increasing use of Tactical Iraqi™, and later Tactical Pashto™, we have gained further insights into how to improve the effectiveness of the system and the instruction that it provides. Some of these lessons are summarized below.

Information about TLCTS and its use has come a number of sources. Military trainees and instructors have provided us with feedback on the software, based on their feedback from using it in training. We conducted train-the-trainer courses for Tactical Iraqi™, i.e., seminars aimed at instructors and trainers, intended to help them understand how to employ Tactical Iraqi™ in training. As part of the train-the-trainer course, participants get hands-on experience in using Tactical Iraqi™. In the process the seminar supervisors get an opportunity to observe the seminar participants as they use the system, note problems, and get feedback from the participants. Independent formal evaluations of the effectiveness of Tactical Iraqi™ are being conducted by Surface, Ward, & Associates at two military installations (the Marine Corps training centre at 29 Palms, California, and the Army training centre at Ft. Riley, Kansas). Alelo has been assisting the collection of data during these evaluations, which has both given us opportunity to observe the training and inspect the data being collected. Finally, we have conducted informal evaluations of TLCTS courses with members of the general public.

4. THE ROLE OF GAMES IN LEARNING

A key question in the design of TLCTS, and in the design of serious games generally, is the proper role of the game in the learning process. The design of TLCTS departs both from the conventional view of the role of games in language learning software and views commonly held in the serious game community. Our understanding of the role of games continues to evolve as we gain experience with the software in use.

Games have long been a component of language learning software. Common examples include the Hangman game,[1] and activities that involve filling in blanks or unjumbling sentences.[2] These tend to be activities of short duration, that either serve as pleasant diversions from the learning process or short exercises that can be conducted during the course of learning.

Although such games can have a place in an on-line language curriculum, they do not contribute much to the objectives of TLCTS, which is to help learners acquire effective communication skills. Most focus on manipulating written words and sentences as puzzles, which do little to prepare the learner for understanding and speaking spoken language. They do not require learners to use their spoken language skills, much less use them with the speed and fluency characteristic of spoken conversation. When games are introduced into a curriculum, learners may be inclined to play them repeatedly in order to reach expert level; it is therefore important that the expertise gained in this manner is relevant to the overall learning objectives. Expert skill in playing Hangman is of little value in face-to-face conversation.

The fundamental problem in designing games for language and culture learning is making sure that the skills acquired in the game transfer to skills needed in the real world. Promoting transferable skills is a general problem in education and learning [2], and it is particularly problematic for language education. Learners who perform well in conventional classroom instruction often experience difficulties communicating when they first arrive in a foreign country.

TLCTS curricula are designed to take learners through a progression of stages from initial exposure to language and culture knowledge to fluent use. The game experiences are designed with this progression in mind. In order to play the Arcade and Mission games well, one needs to be able employ spoken language with a degree of fluency and functional proficiency. Providing trainees with a progression of practice opportunities, both exercises and games, helps promote transfer, since learners are continually transferring their skills from one practice opportunity to the next. Finally, the Mission Game provides learners with a practice experience that bears strong similarities to real-life conversation; this increases the likelihood that trainees will actually be able to apply their skills in real life.

The realism of the Mission Game provides an additional benefit that conventional instruction does not provide: a concrete context for learning. It is well understood that human memory is associational, that as people form memories they make associations with the context in which something is learned, and use the context later to aid in recall. The Mission Game provides learners with a multitude of concrete contexts in which to learn language and culture. For example, trainees in Tactical Iraqi™ may learn the Arabic word for “boots” in the context of entering an Arab household, where they may need to ask the head of the household whether they should remove their boots before entering.

For this reason, we encourage trainees to go into the Mission Game early and frequently, before they have mastered the necessary vocabulary. They are likely to learn in the context of playing the game, and at the very least understand the context in which they will be applying their communication skills. This may motivate them to go back into the Skill Builder and practice the skills that they need to play the game successfully.

[1] http://www.1-language.com/eslhangman/index.htm

[2] http://www.transparent.com/games/index.htm

A common presumption in the serious game community is that learning should occur as an incidental consequence of the game activity. For example, Prensky proposes the idea of "stealth learning," [6] where the educational objective of the game is hidden from the user. Our approach rejects this view: it is well understood throughout that the purpose of TLCTS games is to learn language and culture. For most adults learning language requires focused effort, and if the learning objectives are hidden from the user the user is unlikely to apply the necessary effort. The problems that most language learners face is that they find the task of learning language to be daunting, and the experience of applying imperfect language skills in a foreign country to be intimidating. Games can go a long way to overcoming these barriers. In TLCTS we attempt to design games that are interesting, that reduce the intimidation factor, and give learners the experience of making steady progress in acquiring communication skills. Rather than hide the learning objectives from the user, we seek to give learners as sense that their effort is being rewarded, so that they will continue to devote effort to language learning.

Another important issue in the design of serious games for learning is understanding the relationship between in-game learning activities and out-of-game learning activities. Serious game developers with a game design background tend to focus on the game experience and neglect the non-game activities. Squire and Jenkins in contrast have made the observation that when learners learn through games, they are motivated to engage in other learning activities that will help them acquire knowledge necessary to play the game [7]. TLCTS courses are designed with this observation in mind, and in fact employ it as a design principle throughout. Lessons and learning materials are deliberately designed to develop skills that are relevant to the game, and the game experiences are designed to provide practice that is relevant to the skills being taught. As we have developed TLCTS, we have progressively integrated the game-based and non-game-based activities even more tightly, by incorporating the Skill Builder into the gaming environment and showing learners the mapping between the lesson learning objectives and the game learning objectives. Nevertheless, it is not feasible or appropriate to integrate all learning experiences into the game environment, since learners need opportunities to continue to develop and apply their communication skills away from the computer. This motivates the creation of supplementary learning materials of various sorts, including exercise books and supplements that run on other devices such as handheld devices.

As we have gained experience with the use of TLCTS courses in practice, our understanding of how to employ game experiences effectively has further developed. A critical issue is helping both instructors and learners understand the proper role for games in learning. Instructors and training supervisors often make erroneous assumptions when they encounter TLCTS courses the first time. Some assume that all one needs to do is to hand out copies of the game and trainees will learn on their own without any supervision. Others focus on the Skill Builder lessons, since they are superficially similar to conventionally designed instruction, and use the Mission Game only as a final test of language proficiency. It has proven necessary to provide trainers with orientation courses and example programs of instruction that emphasize the importance of using the lessons and games in combination, and to encourage trainees to alternate between the two.

Likewise, it is important to give learners a good understanding of how best to employ the game experiences to develop their own learning. Some learners proceed through the Mission Game simply by repeatedly asking their assistant for hints of what to say; others focus on the game elements and neglect the lesson components. We are gradually enhancing TLCTS to reinforce good training habits, e.g., by automatically providing trainees with guidance as to how to spend their time, and revising the hint system so that it encourages learners to try out a variety of actions. Meanwhile as instructors gain a better understanding of how to use TLCTS effectively, they are able to monitor trainee performance and provide further guidance.

5. EXPERIENCE WITH THE SYSTEM IN USE

The initial pilot two-week training courses in the summer of 2005 gave initial indications of training effectiveness for Tactical Iraqi^{TM}: seven out of nine trainees who had been to Iraq before, and therefore understood the importance of language and culture training, reported that they felt that course gave them a functional ability in the Arabic within the domain of the course.

The Marine Corps Air Ground Combat Center (MCAGCC) at 29 Palms, CA, has since been using Tactical Iraqi^{TM} increasingly for training, with increasingly promising results. MCAGCC has set up one computer lab with 75 computers, and is in the process of setting up another one. The computers are available both for informal learning, where trainees come in during their spare time and train on their own, and supervised training, where units come into the lab at set times and conduct training as part of their overall training schedule.

During the summer and fall of 2006, two Marine units conducted organized supervised training. The 2nd Battalion, 7th Marine Regiment (2/7) conducted blended training over four weeks, in which they engaged in alternate weeks of in-depth classroom instruction and two hours a day of Tactical Iraqi^{TM} training. The 3rd Battalion conducted ongoing training with Tactical Iraqi^{TM}, two two-hour training sessions per week.

After completing training, the 2/7 Marines conducted a final training exercise called Mojave Viper, in which the Marines conduct operations that require them to interact with Iraqi role players. The role players reported that the 2/7 Marines had far more knowledge of Arabic than any previous unit.

The 3/7 Marines were divided into three experimental groups, depending upon which company they belonged to. One group was able to use all components of the training system, and received regular instructor supervision. The second group used all components of the system without regular instructor supervision. The third group used only the Skill Builder, without instructor supervision. Of the two groups that worked without supervision, the group that used the entire training system achieved higher learning gains. Of the groups that used the entire system, the one with supervision achieved only slightly better results than the unsupervised group. Thus the game components of Tactical Iraqi™ led to improved learning gains, and reduced the need for supervision.

In informal observations of the 3/7 Marines during training, it is clear that the trainees are consistently engaged in the learning activity and making good progress. These appear to be quite typical of Tactical Iraqi™ users. As Mr. Paul Nichols, a former Marine gunnery sergeant and program manager for TCLTS in the Marine Corps has observed: "If somebody's skeptical of the idea of a video game training soldiers and Marines, I'd just tell them to come down and watch how driven and immersed they get with the program."[3]

6. CURRENT STATUS AND FUTURE WORK

Tactical Iraqi™ is in increasingly widespread use. At the time of this writing over 1800 copies have been distributed by our team, primarily to the US military. Anyone with a .mil email account is entitled to download free copies, and there are at least a hundred downloads a month. Some training installations are also redistributing copies within their units.

Major Tactical Iraqi™ training laboratories have been established at a number of military installations, including 29 Palms, CA, Ft. Riley, KS, Ft. Stewart, GA, Ft. Benning, GA, and Schofield Barracks, HI. Many are training large numbers of people. For example, Ft. Riley has two hundred forty computers installed with Tactical Iraqi™, and has trained thousands of trainees. The US Marine Corps will be setting up training labs shortly for Tactical Pashto™.

Additional TLCTS courses are under development. Tactical French™ teaches the language and culture of French-speaking countries in sub-Saharan Africa. Other military training courses for other languages are being considered, as well as variants for use in other countries. Meanwhile, we are developing a separate prototype course, named Mission to France, which is designed for business people traveling to France. This will give an opportunity to evaluate how to apply the Tactical Language approach to non-military users.

Meanwhile, further independent evaluations of Tactical Iraqi are planned. One will take place in February at Ft. Riley, KS, involving 350 soldiers. The trainees will participate in a blended training program including Tactical Iraqi™ and classroom instruction.

Although Tactical Iraqi™ and related courses are designed to develop functional skills in specific task-related areas, there is substantial anecdotal evidence that trainees are requiring general spoken language proficiency as well. We plan to take advantage of this by extending the TLCTS courses to prepare trainees to pass the spoken portion of the Defense Language Proficiency Test (DLPT) at an Interagency Language Roundtable (ILR) level of 1. This should further motivate Marines in particular to train, because once they pass the DLPT they will receive a bonus in pay.

[3] Westhead, R. (2007). Lose the helmet, win their hearts. *Toronto Star*, Jan. 12, 2007.

7. ACKNOWLEDGMENTS

The author wishes to acknowledge the contributions of the Tactical Language Project team members at Alelo, its subsidiary Tactical Language Training LLC, and at the University of Southern California, including Andre, Valente, Hannes Vilhjálmsson, … This work was sponsored by DARPA, SOCOM, PM TRASYS, and RDECOM. Opinions expressed here are those of the author and do not reflect the official position of any of the sponsoring organizations or the US Government.

REFERENCES

1. Beal, C., Johnson, W.L., Dabrowski, R., & Wu, S. (2005). Iterative feedback and simulation-based practice in the Tactical Language Training System: An experimental evaluation. *Proceedings of the International Conference on Artificial Intelligence in Education*. IOS Press, Amsterdam.

2. Bransford, J., Brown, A.L., & Cooling, R.R. (2002). *How People Learn: Brain, Mind, Experience, and School*. National Academy Press.

3. Johnson, W.L. and C. Beal, C. (2005). Iterative evaluation of a large-scale, intelligent game for language learning. *Proceedings of the International Conference on Artificial Intelligence in Education*. IOS Press, Amsterdam.

4. Mote, N., Johnson, W.L., Sethy, A., Silva, J., & Narayanan, S. (2004). Tactical Language Detection and Modeling of Learner Speech Errors : The Case of Arabic Tactical Language Training for American English Speakers. InSTIL-ICALL Symposium, Venice, Italy

5. Nielsen, J. (1994). Guerilla HCI: Using discount usability engineering to penetrate the intimidation barrier. http://www.uesit.com/papers/guerilla_hci.html

6. Prensky, M. (2001). Digital Game-Based Learning. New York: McGraw Hill.

7. Squire, K. & Jenkins, H. (2003). Harnessing the power of games in education. *Insight* 3 (5), 7-33.

8. Vilhjálmsson, H. & Samtani, P. (2005) MissionEngine: Multi-System Integration using

Python in the Tactical Language Project. PyCon 2005.