

Multi-Platform Delivery of Game-Based Learning Content

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Abstract

The Alelo Language and Culture Training System is a game-based system for learning foreign language and culture, where learners practice their spoken communication skills in 3D virtual worlds inhabited by interactive non-player characters. The platform has been used to create several training systems for military use: *Tactical Iraqi*, *Tactical Pashto*, *Tactical French*, and *Tactical Dari*. It is also being used to develop non-military courses to teach Arabic, French, Cherokee, and other languages. Learners who start with no knowledge of foreign language can reach ILR level 0+ proficiency in just a week of training. This presentation describes progress in re-targeting content to a variety of platforms: the Web, iPods, and handheld computers.

Keywords: game-based learning, language education, learning platforms

Introduction

The Alelo *Tactical Language and Culture Training System* (TLCTS) is a game-based learning platform that helps people quickly develop functional skills in foreign language and culture. Heavy emphasis is placed on spoken communication. Learners get extensive practice in speaking the foreign language because they must speak in the foreign language to interact with the software. Learners with no prior knowledge of the language are able to learn effectively with it. Independent evaluations of TLCTS courses (Surface et al., 2007) show that learners develop functional communication abilities in as little as a week of training.

TLCTS courses are in increasingly widespread use, particularly in the US military and by military services in other countries. Four military training courses have been developed so far. *Tactical Iraqi*TM teaches colloquial Iraqi Arabic and the culture of Iraq. *Tactical French*TM teaches the language and culture of French-speaking sub-Saharan Africa. *Tactical Pashto*TM and our newest course *Tactical Dari*TM teach the languages and culture of Afghanistan.

Tens of thousands of military trainees have used these courses as part of their pre-deployment training. Just one training site, at Ft. Riley, KS, trains approximately 10,000 each year. The Marine units that recently were called to deploy to Afghanistan have integrated Tactical Language and Culture training into their predeployment training. This represents a significant change in military training practice. In the past military service members deployed overseas had little or no knowledge of the local language, and relied on interpreters and a small cadre of trained linguists. Thanks to TLCTS courses, units deploying overseas now have large numbers of soldiers and marines with effective foreign language skills. The 7th Marine Regiment, for example, assigns two marines per squad, or approximately one in 10 marines, to train intensively with TLCTS courses prior to deployment. Officers report that their marines' improved communication abilities has led to improved operational effectiveness of their units.

Although the TLCTS platform was originally developed to meet the needs of military trainees, there is nothing military-specific about the approach. In fact, the pedagogical approach underlying TLCTS, called task-based learning (Ellis, 2003), is widely used in modern second-language learning. TLCTS is now being applied to several non-military courses. Mission to IraqTM is designed for businessmen and employees of nongovernmental organizations. A pilot French course, Mission to France, is being evaluated for inclusion in college French curricula. A pilot Chinese course, iSpeak Chinese, is being developed in collaboration with Yale University Press. A pilot Cherokee course has been developed in collaboration with Thornton Media, Inc. Each course incorporates interactive lessons help learners acquire communication skills, and interactive games that learners use to practice and further develop those skills.

This paper describes the overall TLCTS approach to learning, and the technology platform that supports it. A key challenge is how to support the delivery of multiple courses on multiple platforms. Authoring tools and data representations, have made it possible to create several game-based learning environments, not just a single educational game. The platform supports the development of the full range of educational materials needed of

computer-based courses. Multiple hardware and software platforms are supported, from PCs to iPods. This helps make learning content available to learners whenever and wherever they want to learn.

System Overview

Game Experiences

Every TLCTS course includes a Mission Game, an interactive 3D game in which learners carry out tasks and missions requiring them to speak with people in the target language. Figure 1 shows an example scene from the Mission Game in the Canadian version of *Tactical Pashto*. The player (crouching in the center of the figure) has a mission to assume management of a reconstruction projection in an Afghan village. In the scene shown in the figure, the player has entered the village for the first time and is speaking to some of the children as way of establishing rapport with the people in the village. One of the children, indicated by the red arrow at the top of the image, has just said hello to the player. The other children are listening in on the conversation and may interrupt or join in. The icons on the right edge of the figure, called rapport meters, indicate which characters are listening to the conversation, and what their current attitude is toward the player.



Figure 1. Example Mission Game dialog

The responses of the characters in the game can vary dynamically depending upon their level of rapport with the player. Players can develop rapport in a various ways. In this example, simply taking the time to talk to the children is an indication of friendly, peaceful intentions, and causes the adults in the village to be favorably disposed to the player. Adherence to cultural norms of politeness and proper forms of address can build rapport. The user interface permits the learner to select nonverbal gestures for their character to perform, and these help develop rapport as well. Such non-verbal gestures are particularly

useful for modeling culture in countries like Iraq and Afghanistan, where the gestures often mean very different things from that they mean in the West.

Mission Game scenarios give learners opportunity to practice their communication skills in realistic, concrete situations, and develop fluency. They are also designed to enable learners with very limited language skills to get started easily. If at any time the learner asks for help, the system displays a menu of possible things the learner might want to say in this context (e.g., greet the boy, ask his name, ask him for information about the village, etc.). It can also show examples of ways of expressing these in the target language. This allows learners to pick up vocabulary and phrases while playing the game, or find out what vocabulary they need to learn to play the game. Their score in the game depends in part on their use of language; the less they rely on hints to play the game, the higher a score they can attain.

In addition to the Mission Game, learners can play one or more casual games that focus on specific language skills. The Arcade Game serves this role in most TLCTS courses. The Arcade Game is a Pacman-like game in which learners gain points by saying or responding to spoken commands to move through a stylized town (e.g., “turn right at the police station”). When colored enemies appear, one destroys them by saying their color. The Arcade Game involves simpler use of language than the Mission Game does, but it is faster-paced and encourages learners to practice many times.

Interactive Lessons



Figure 2. Example Skill Builder exercise

In addition to the game experiences, TLCTS courses incorporate a group of interactive lessons, called the Skill Builder, which helps learners acquire particular communicative skills. Figure 2 shows an exercise page from the Skill Builder in *Tactical French*. This exercise is part of a lesson on the topic of meeting strangers. It is an example of an “utterance formation page”, an exercise that

gives learners practice with a particular dialog exchange. In this example the learner must say goodbye to a Chadian woman, Halimé, whom he or she has just met. The learner said “Salut”, which a Chadian new acquaintance would likely consider to be too informal. The system therefore gives the learner feedback regarding the mistake. Feedback can be either positive or negative, and can address a wide range of errors, including cultural pragmatics as in this case, as well as errors in word choice grammatical errors, morphological errors, and pronunciation errors.

Evaluations with learners have made clear that learners prefer having the Skill Builder lessons and the game environments integrated into a single learning environment, so that learners can easily go back and forth between the lessons and the games (Johnson & Beal, 2005). We have integrated the Skill Builder and the Mission Game more closely over time, although they continue to differ in focus (the lessons are more study-oriented, while the games are more practice-oriented). The Skill Builder employs the same animated character technology that the Mission Game employs to create characters that the learner can converse with in the foreign language. The Skill Builder lessons include a series of lesson and exercise pages that progressively prepare the learners to engage in conversation. Lessons usually culminate in one or more “active dialogs”, in which learners can engage in an extended conversation with an animated character. Figure 3 shows one such active dialog in the *Tactical Dari* Skill Builder, where the player is asking a villager for directions. These active dialogs serve as an intermediate point between utterance formation pages, which focus on individual conversational exchanges, and the Mission Game, which simulates extended, free-play conversation.

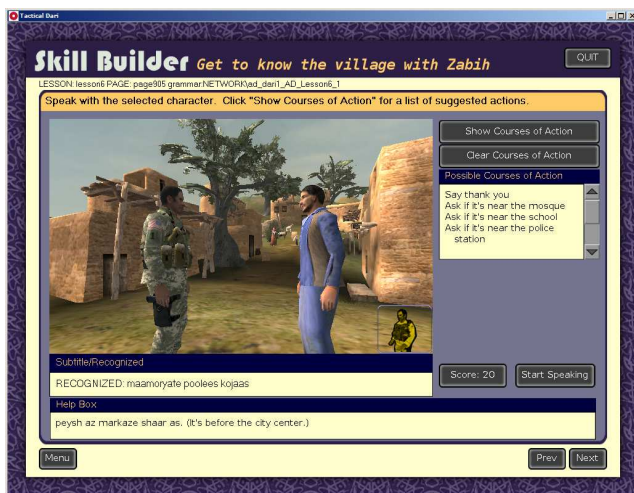


Figure 3. An active dialog

Supplementary Companion Materials

We are now expanding the range of platforms on which TLCTS content is delivered, so that learners can have access to learning content anywhere, anytime. Our users are now beta testing a new companion product, called the iPod Companion, which plays on Apple iPods (Figure 4). The iPod Companion includes the same example dialogs and lesson pages as the PC Skill Builder, adapted for display on a small screen. Voiceover narrations are added so learners are not required to read off the screen. The product includes a glossary so learners can look up and review individual words. This enables learners to continue to practice and maintain their skills when they do not have access to a computer.



Figure 4. *Tactical Iraqi*™ iPod Companion

We also produce printed booklets that include cultural lesson materials as well as dialog texts. Learners can use these to practice dialogs with their friends so they get more experience conversing with other people instead of just with computers.

We have also developed prototype companion trainers for other handheld devices, including the Sony PlayStation Portable and the GP2K. We have ported some of the interactive capabilities of the PC TLCTS to these platforms, as well as some speech recognition capability. As we port additional functions to these platforms, it will be increasingly possible for learners to develop their language and culture skills anywhere, anytime.

Underlying Advanced Technologies

TLCTS incorporates several advanced, patent-pending technologies that make possible the interactive learning materials illustrated above. Automated speech recognition (ASR) is one of the most important and pervasive technologies. TLCTS employs speech recognition models specifically designed to support language learners. The models are trained both on the speech of native speakers of the target language, and on the speech of language

learners. This helps ensure that the speech recognizer tolerates the heavy accents of language learners. The speech recognizer also incorporates a default “garbage model” to handle cases where the learner’s speech falls outside the set of phrases and grammatical forms that are covered in the lessons and games. We calibrate the degree of tolerance of incorrect and ungrammatical language by adjusting the garbage model’s parameters. We also employ different language models in different parts of each TLCTS, enabling it to select the types of language it recognizes and the range of language errors it can detect.

To support the conversational interaction in the Mission Game and the Skill Builder active dialogs, TLCTS courses incorporate social simulations. That is, interactions with animated characters in social settings. Learners can communicate with non-player characters using a combination of speech and gesture. The system processes the learner’s input to determine the learner’s communicative intent, and non-player characters may react to that communicative intent by adjusting their level of rapport with the learner or their knowledge of the state of the virtual world. The characters then choose an appropriate response. Finally, the character’s response is realized as a combination of speech and gesture. TLCTS thus implements artificially intelligent interactive characters, limited by the vocabulary knowledge of the learner and the context of the training scenario.

As the learner interacts with TLCTS, it maintains a learner model that estimates the learner’s level of mastery of each component communicative skill. The target skills are modeled in a hierarchy of enabling learning objectives (ELOs). Authors annotate exercises, quiz items and dialogs to indicate what ELOs they require. Each time the learner completes an exercise or dialog, the learner model updates its estimate of mastery of associated ELOs, using a method inspired by the model tracing technique of Corbett et al. (1995). The learner model provides trainers and researchers with a rich view of the learners’ progress, and we plan to use it to guide learners on how to direct their learning efforts to improve their skills.

The Alelo Architecture

The underlying architecture of TLCTS supports the range of platforms illustrated in the previous section as well as additional ones such as the Web. Unlike other game-based learning systems that target a single learning platform or a single game, TLCTS supports a spectrum of learning platforms. It also supports the creation and maintenance of multiple related variants of learning environments for different classes of users. The illustrations in the above figures illustrate the kinds of problems that TLCTS faces. The iPod Companion reuses the content developed for the PC, but some adaptations are required due to the device’s small screen. Different versions of courses must be created

for different classes of users. Content developed for US military forces must be adapted for use by Canadians, Australians, and other countries; not only must the uniforms of the characters change, but also some of the language and voiceovers. There are even differences between US Army and US Marine Corps versions that affect user acceptance (Johnson 2007). TLCTS implementations support the range of advanced technologies listed above, to the extent that they are supported on each hardware platform.

Figure 5 shows the overall architecture. All content in TLCTS courses is specified in XML, and stored in a common content repository. Multidisciplinary teams of language and culture experts, animators and other artists, multimedia production specialists and programmers contribute to the content specifications. As we develop and improve our content specifications and authoring tools, we have largely eliminated the role of programmers in content development.

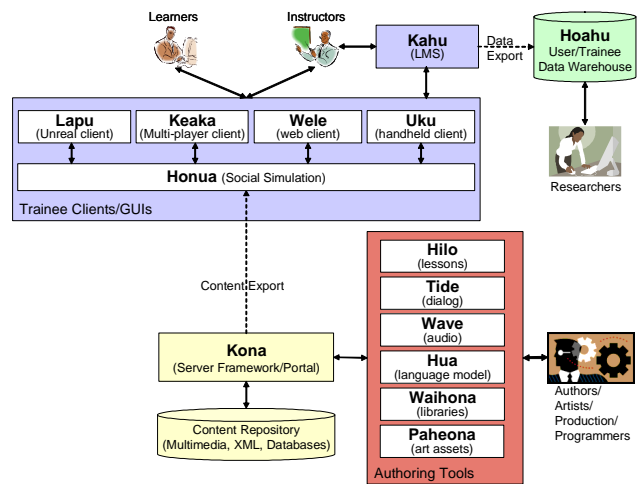


Figure 5. Overall Alelo architecture

A Web portal named Kona¹ provides access to the content repository. Each course in Kona is represented as a “book” that contains a set of chapters, each of which is a specification of an individual lesson or scene. Kona is designed to support collaborative editing and review. Project members can lock individual chapters and edit them using a suit of Web-based authoring tools. Kona supports version control, preventing simultaneous edits and allowing roll-back to previous versions.

A suite of authoring tools operates on the content specifications. *Hilo* is used to create specifications of lessons, exercises and quizzes. It invokes other authoring tools on individual content specifications as needed. *Tide*

¹ Many of the architecture components have Hawaiian names, reflecting the first author’s connection with Hawaii (see e.g., <http://www.longmountainkona.com>). See the glossary at the end of this paper.

(Tactical Language Interactive Dialog Editor) is used to create dialog models and scripts for use in lessons and game scenes. *Hua* is used to create lexicons and inventories of phrases for use within *Hilo* and *Tide*. *Paheona* and *Waihona* are used to create libraries of art assets and language assets respectively, for use in content specifications. *Wave* is used during production to edit sound recordings and link them to lesson and game content so they are loaded with the content onto the delivery platforms and are playable.

Content is delivered on a range of platforms. The *Lapu* client runs on videogame PCs. It is built on Epic Games' Unreal Engine 2.5 game engine. We licensed the source code for Unreal Engine, and modified and expanded it to support the full range of technologies (e.g., speech recognition) and media (e.g., videos) required for delivering TLCTS content.

The *Uku* client runs on handheld devices, with different versions different client devices (iPod, PlayStation Portable, GP2X, and Windows Mobile). To support *Uku*, media assets (instructional texts, recordings, images, and videos) are extracted from the repository and converted into formats that supported by the devices. The greatest amount of conversion is required for the iPod client. Dialog animations must be converted into videos, and sound files and images must be converted into iPod-compatible encodings.

A new Web-based client, name *Wele*, has been prototyped and is now being further developed. In *Wele* a Web browser provides the user interface. Support for graphical dialog environments is delivered with Adobe Flex 2 as Flash files inserted into Web pages. The speech recognizer is the same used in the *Lapu* client, packaged as a plug-in. *Wele* currently supports only the Skill Builder; however, we plan to extend it soon to support game experiences. *Wele* provides a rich learning experience to learners who either do not have access to videogame-capable PCs or cannot download and install large software installers onto their computers.

Up to now TLCTS has been employed as a single-user learning system. Our new multi-user client, name *Keaka*, to changes this. *Keaka* links multiple user clients over a network so groups of learners and virtual humans can interact. Learners speak to each other, possibly in English, and speak to virtual humans in the target language. This enables the creation of multi-user training environments, particularly for the military, where language and culture training is combined with other types of training. *Keaka* currently runs as an extension to the Unreal Engine; however, we plan to develop soon implementations for other game-based training platforms, such as RealWorld and VBS2.

Each TLCTS implementation offers some form of social simulation; that is, animated characters able to engage in

conversations and social interactions with learners. Each client includes a module to implement the social simulation substrate, called *Honua*. *Honua* is implemented in a platform-independent fashion, so it can be integrated into different TLCTS clients.

Figure 6 shows how social simulation interacts with the rest of the learning environment in the *Lapu* client, and illustrates how social simulation supports user interaction in general. The learner communicates with virtual humans using a combination of foreign language speech and gestures selected from a menu. The Input Manager generates a representation of the meaning of the learner's input, called a communicative act. Examples of communicative acts include greetings, exchanges of information, and requests. The Social Simulation Engine determines how the environment and the characters in it respond to the learner's input and other actions. Virtual humans ("agents") may react by changing their mental states, e.g., adjusting their attitudes toward the learner or their beliefs about the state of the world. The agents then choose actions to perform in response to the learner. The agents' actions are realized by an Action Scheduler, which issues a set of commands to the game engine to move the agent's body parts and/or to speak. As the learner interacts with the system, the Learner Model is updated to estimate the learner's current level mastery of the skills necessary to play the game. Interaction logs and recordings of the learner's speech are saved for subsequent analysis and reporting purposes.

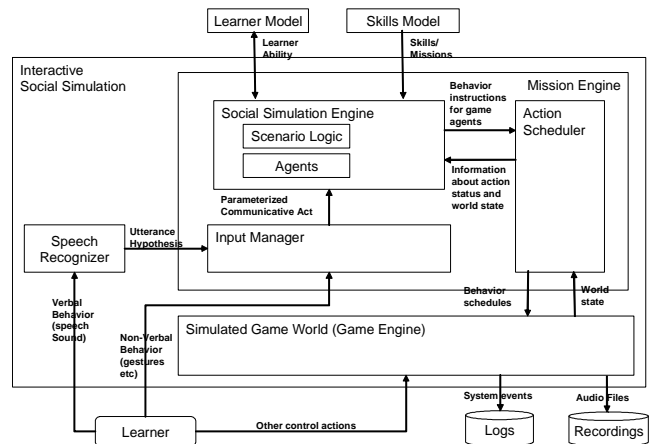


Figure 6. Lapu client simulation architecture

TLCTS provides support for managing learners and tracking their progress and usage of the system. A lightweight learning management system called *Kahu* communicates with the learner clients over a local network. Unlike Web-based learning management systems that assume continuous access to the Internet, *Kahu* supports discontinuous access. Learners can work on their computers or handheld devices at home or in the field, then bring them into a computer lab and connect them to the

local *Kahu* server. *Kahu* then updates its record of the learner's progress. *Kahu* generates reports of learner activities, for training supervision and research purposes. We collect learner profiles and examples of the speech recordings, and save them in a data warehouse called *Hoahu*. The recordings are used to incrementally retrain and improve the speech recognizer. The interaction data and samples of learners' speech production help us to track how learners use the system and how well they learn. They may suggest ways of further improving the system.

Authoring Support

The following section describes in more detail some of the tools and processes employed to author TLCTS content. TLCTS authoring tools have unique characteristics that multi-platform delivery and mixtures of game-based and instructional content. WYSIWIG (What You See Is What You Get) editors are of limited value in the TLCTS content because the layout of the content depends on the particular client platform. Instead, our authoring tools focus more on the underlying semantics of the context. They enable authors to manipulate the XML specifications of content, without requiring any knowledge of XML.

Scene and Dialog Authoring

The *Tide* authoring tool specifies dialogs throughout TLCTS, including Mission Game scenes and the Skill Builder's dialogs and dialog fragments. *Tide* allows authors to build complex dialogs from smaller elements without knowledge of specialized programming or knowledge-representation languages.

Dialogs are specified in *Tide* in two layers. In the utterance layer, authors specify the range of utterances that learners and virtual humans can speak. Currently, utterances are individual phrases; however, we have implemented a more powerful framework, called utterance templates (Meron et al., 2007), which allows authors to specify grammars of possible utterances. In the act layer, authors specify the communicative acts that represent the meaning of collections of utterances or utterance templates.

Tide allows authors to describe dialogs using either scripts or dialog graphs. Scripts are linear sequences of utterances, either between two virtual humans or between a virtual human and a learner. Scripts can be used directly as specifications of scripted example dialogs, or as illustrations of possible exchanges that can occur in a complex interactive dialog. Dialog graphs specify the range of possible interactions that can occur in a dialog, at the act level. Figure 7 shows an *Tide* dialog graph. The graph notation resembles a flow chart but includes special graphical constructs that make it easier to express possible dialog exchanges concisely. An example of such a construct is the Range Enabled Transition (RET), shown as

the grey box on the right side of the figure. RETs specify dialog paths that are enabled only at certain points of the dialog. RETs are commonly used to specify subconversations dealing with particular topics. As the dialog progresses from topic to topic, RETs dealing with each topic are selectively activated and deactivated.

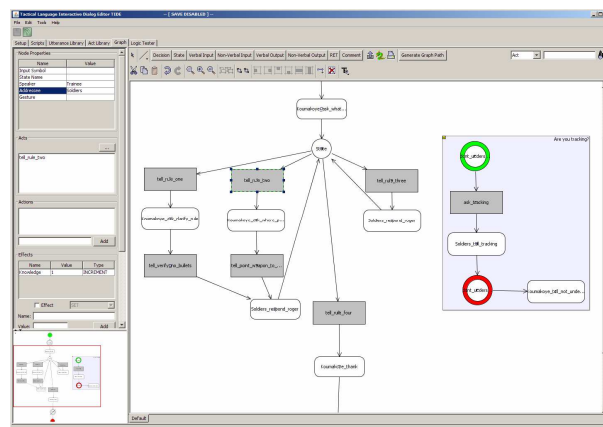


Figure 7. Tide authoring tool

Tide incorporates a validation tool that allows authors to test implemented dialog models against the dialog graph specifications. Authors can walk through the dialog step by step, and ensure that the dialog options provided by the dialog model correspond to what is indicated in the specification. It also allows the authors to imagine what the learner might want to say in a given context, and ensure that the dialog graph includes those possibilities. One of the most difficult aspects of dialog authoring is imagining what people might say when they are immersed in a dynamic dialog context. Authors tend to write dialogs as scripted screenplays, only to discover that learners do not follow a script when interacting with the system.

Lesson and Exercise Authoring

The *Hilo* authoring tool specifies the instructional elements, exercises and quizzes in Skill Builder lessons. The tool provides special support for maintaining the correspondences between texts in multiple languages and orthographies. Figure 8 shows an example of *Hilo*, applied to French language content. Authors can view and edit each foreign language utterance in written form, its "ez-read" Roman transcription for learning purposes, its English translation, and its transcription as a sequence of phonemes as used by the speech recognizer. Authors can color code elements of each form so learners can see the correspondences. Utterances are linked to an utterance library where they can be managed and tracked. Language-specific tools built into *Hilo* help manage the correspondence between the different forms of utterances. For example, the French version of *Hilo* automatically looks up the pronunciation of French words, and helps with

the generation of phoneme ez-read transcriptions of written French texts.

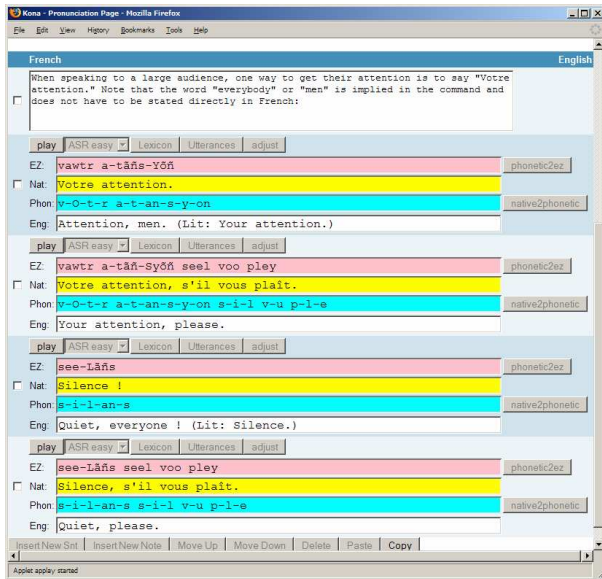


Figure 8. Hilo lesson authoring tool

Hilo provides ways for tagging pages as applying only to certain classes of users or platforms. This allows us to maintain slightly different versions of the same course for different target audiences. For example, we customize the ranks and titles in our military courses for each military force — the US Army rank of Sergeant First Class becomes Gunnery Sergeant in the US Marine version and Warrant Officer in the Canadian Forces version. Written texts in the PC client versions are edited for voiceover narration in the iPod Companion version. We are also starting to tag learning content for their difficulty level. Learners who seek high levels of language proficiency receive advanced exercises that basic learners do not.

Hilo also allows authors to record spoken examples of the phrases being taught and use. These “scratch recordings” are used when prototyping TLCTS courses and validating their content. Later in the production process we replace the scratch recordings with recordings of professional voice actors.

Impact of Authoring Tools

These authoring tools have enabled us to increase the quality and quantity of authored content, and have made it possible to maintain multiple versions of content for different classes of learners and different platforms. Table 1 shows some of productivity improvements that these tools are yielded. It compares *Tactical Iraqi* v3.1, developed in 2006, *Tactical Iraqi* v4.0, developed in 2007, and *Tactical French* v1.0 also developed in 2007. The authoring tools doubled the number of lesson pages, vocabulary words, dialogs, and Mission Game scenes in *Tactical Iraqi* v4.0 vis-à-vis v3.1. Development of *Tactical*

French v1.0 did not start until late 2006, yet it has about the same amount of Skill Builder material as *Tactical Iraqi*.

Content Metric	TI 3.1	TI 4.0	TF 1.0
Lessons	35	52	40
Lesson pages	891	2027	1920
Words	1072	2214	1820
Example dialogs	42	85	67
Active dialogs	13	29	36
Scenes	8	18	9

Table 1: Content size of TLCTS courses.

Our authoring tools allow easy production of interim versions of courses for client review, and let us respond quickly to urgent requests for training content. This have proved critical for the development of *Tactical Dari*. As we develop content for this course, we send interim versions to for review by Dari experts working for the Defense Language Institute Foreign Language Center. In January 2008 the Marine Corps received the order to redirect forces to Afghanistan, and we were able to quickly prepare a preliminary version of *Tactical Dari* that they are already using in predeployment training.

We are also using our authoring tools in collaborative projects with other organizations. A project with Thornton Media Inc. has developed a pilot for a course named *Rez World* for young Cherokees to learn Cherokee language and culture. Other games for other Native American languages are being planned. A Chinese course, named *iSpeak Chinese*, is being developed in collaboration with Yale University Press.

Support for Handheld Devices

As described above, we have developed *Uku* handheld clients for several mobile platforms, including the Sony PlayStation Portable, Windows Mobile and iPod. Each platform had its own porting issues and requirements, and each client implements a subset of the system’s functionality. In general, the functionality is a subset of the Skill Builder; the Mission Game is clearly harder since it uses a 3D game engine.

The first mobile platform we used was the PlayStation Portable (PSP) from Sony. Development for this platform is similar to development for a gaming console and requires a deep understanding of the platform because the development process is very close to the hardware. The advantage is we can achieve high performance from the available hardware. The downside is the large amount of code and effort that is required to produce the application.

After we built the prototype for the PSP platform, we ported the existing architecture to the Windows Mobile platform. We took advantage of the extensibility and abstraction level of the original implementation.

Developing for a console requires a lot of platform-specific code and makes it difficult to port to different platforms, but with the correct placement of abstraction layers it was possible to port significant portions of the application to this new platform. Finally, we reused content processing tools from the PSP version (more details below).

The latest addition to the supported handheld platforms is the iPod. The implementation is separate from the previous mobile versions because the iPod does not allow the construction of a custom user interface. Instead, we employed a simple mechanism that uses HTML-like “notes” linked to audio and video files. While we could not reuse the custom code from the PSP and Windows Mobile, we adapted some of the content tools.

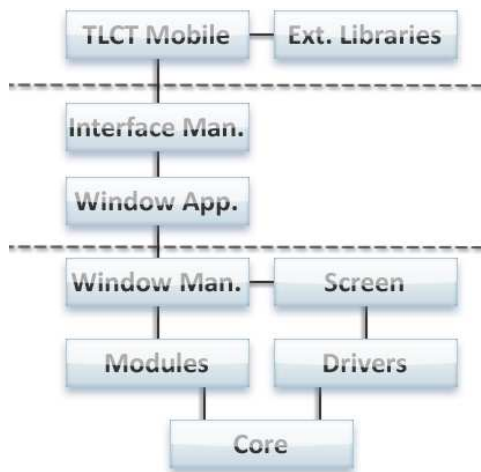


Figure 9: Uku Architecture.

Figure 9 shows the overall architecture of *Uku* (TLCTS Mobile). It has three large abstraction layers that allow porting it more easily to different platforms. The lower layer containing the core, modules and drivers usually have to be rewritten partially or fully when porting to a new platform. These components can be very close to the hardware or be replaced by existing frameworks and libraries already existing on the targeted platform. In the case of the PSP these components had to be custom created. For Windows Mobile the layer was almost completely replaced by an existing framework. The second (middle) layer is easily ported as it usually touches only the components in the bottom layer; this abstracts the second layer from the platform and lets it run on any platform which has the other components already ported. This layer provides controlled access to the screen (instead of direct access) with content shown in windows and resizable content areas. Windows Mobile devices, for example, differ in screen size quite a bit and require the application to render its content very dynamically. The third and top layer is the actual implementation of the Skill Builder. It uses satellite libraries available for the platform (and that are available for all the platforms TLCT is targeted at) but is completely abstracted from the hardware or operating

system. Usually this layer requires no modification when porting to a new platform but contains extensive code for rendering the different types of pages and lessons that are available within TLCTS.

Content Conversion

A key element of our strategy is to re-purpose content from one platform into another, and create tools to automate the process as much as possible. This has proven to be a huge advantage since we do not have to produce the content several times. A key part of the implementation of the strategy relies on the use of XML specifications of content that can be automatically processed.

In the case of *Uku*, we wrote several tools to convert the content and media to the target platforms. This kind of conversion is relatively simple, consisting mostly of format conversions, e.g. scaling down images and re-encoding audio to fit with the constraints of the mobile platform. Most were combined into one “build” tool that creates a complete content release for a given mobile platform.

The XML specifications themselves had to be manipulated in some cases. Skill Builder specifications for a given course (say, *Tactical Iraqi*) are stored in a single XML file that contains tags specifying lessons and pages. Because of the limited processing capabilities of mobile devices, parsing a single large XML file takes too long, so we developed tools to break up into smaller XML containing one lesson each. This process is performed by the content tools.

Results to Date

TLCTS courses are in widespread military use, particularly by the US Marines and US Army. Learners train in dedicated computer training labs or on their own. Anyone with a .mil email address can download copies for their own use or for redistribution to other military service members. In November 2007, a typical month, we measured over 1000 downloads, including 732 copies of *Tactical Iraqi*, 327 copies of *Tactical Pashto*, and 129 copies of *Tactical French*.

Patterns of usage vary widely, depending upon the availability of study time and suitable computers. Military units engaged in predeployment training are rarely able to devote more than 40 hours to TLCTS training due to conflicting demands on training time. Some units combine computer-based training with classroom training if instructors are available. However, for less commonly taught languages such as Pashto and Dari suitable instructors are difficult to find, so some units rely entirely on TLCTS training.

Several independent evaluations of *Tactical Iraqi* and *Tactical Pashto* have been performed, both by the US

military and by forces in other countries. Surface et al. (2007) report results from three different studies: one with military advisors training at Ft. Riley, KS, one with marines in the 7th Marine Regiment, and one with a group of subjects at the Defense Language Institute Foreign Language Center (DLIFLC). All trained for a total of 40 hours, either with *Tactical Iraqi* alone or in blended programs of instruction. All showed significant learning gains, as well as increased self-confidence in communicating in Arabic. The DLIFLC group underwent proficiency testing via oral proficiency interviews, and 75% of participants obtained a score of 0+ (i.e., novice advanced). This is probably a low estimate of job-related language performance, since the version *Tactical Iraqi* that was used in this study focused on mission-specific language skills and was not designed to promote general language proficiency.

Two battalions of the 7th Marine Regiment underwent *Tactical Iraqi* training in 2006 prior to their deployment to Iraq and returned in late 2007. Each battalion had assigned two members of each squad (approximately one in 10 marines) to undertake 40 hours of Iraqi Arabic training. The 2nd Battalion, 7th Marines (3/7 Marines) undertook a blended training program, while the 3rd Battalion, 7th Marines (3/7 Marines) trained entirely with *Tactical Iraqi*. Both units had successful tours of duty, but the 3/7 had a particularly noteworthy success — they did not experience a single combat casualty during their entire tour of duty. The Marine Corps Center for Lesson Learned is conducting a study of this group. Interviews of the commanding officers of the 3/7 conducted as part of this study reveal several interesting and important findings. In the opinion of the officers, the training greatly increased the battalion's operational capability as it enabled it to operate more efficiently with an increased understanding of the situation and better relationships with the local people. They felt that the Marines who trained with *Tactical Iraqi* achieved a substantial level of language proficiency, so much so that they deserved to receive college credit for the language proficiency they gained. Further data was collected from individual Marines, and is currently being analyzed to assess the role of *Tactical Iraqi* in achieving these gains. These results, while preliminary, suggest that *Tactical Iraqi* training led to improved on-the-job performance (a Kirkpatrick level 3 result) (Kirkpatrick, 1994) and this in turn contributed to improved organizational outcomes (a Kirkpatrick level 4 result).

Meanwhile, the 3/7 Marines are back in 29 Palms, and are preparing for next deployment to Iraq in a year's time. The Marines who trained with *Tactical Iraqi* in 2006 are now acquainting themselves with the latest version of *Tactical Iraqi*, and preparing to mentor the next group of Marines learning Arabic with *Tactical Iraqi*.

Based on their success with *Tactical Iraqi*, the US Marines are expanding their use of TLCTS courses and making

them a standard element of predeployment training. At the time of this publication, the 2/7 Marines are scheduled to start a round of intensive training with *Tactical Pashto*, again training two marines per squad, or a total of 96 Marines. Meanwhile, the officers of the 2/7 are developing their Dari skills using *Tactical Dari*. We are collecting data from these training sessions in to assess which learners achieve the greatest success with TLCTS courses. TLCTS courses have been incorporated into a suite of computer-based training courseware that the Marine Corps is making available to Marine trainees around the world.

Although we are pleased with the success of TLCTS courses to date, we continue to conduct research evaluations to understand under what conditions TLCTS is most effective, and how to make it more effective. Of particular interest is the question of how game-based learning contributes to the overall success of the approach. Although games have attracted significant interest as a way to promote learning, studies of their effectiveness have yielded mixed results, which as led some researchers to question their value (O'Neil et al. 2005). In the case of TLCTS the situation is complicated because it contains both interactive lessons and game experiences. Moreover, we continue to draw technologies and design techniques from the game side of TLCTS and apply them on the lesson side. As a result TLCTS Skill Builder lessons are becoming increasingly interactive, make greater use of animation, and employ game design elements such as scoring. Nevertheless, we find that the game environments continue to provide a quality of experience that the lessons lack; they promote learner motivation and interest, and provide learners with a needed change of pace after long periods of hard study in the Skill Builder. This suggests that as handheld versions of TLCTS become more prevalent, we will need to add game experiences to them.

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References

- Corbett, A., & Anderson, J. R. 1995. Knowledge tracing: Modeling the acquisition of procedural knowledge. *User Modeling and User-Adapted Interaction*. 4.
- Ellis, R. 2003. *Task-based language learning and teaching*. Oxford: Oxford University Press.
- Johnson, W.L. 2007. Serious use of a serious game for language learning. In: Luckin, R. et al. (eds.), *Artificial*

Intelligence in Education, pp, 67--74. Amsterdam: IOS Press.

Johnson, W.L. and Beal, C. 2005. Iterative evaluation of a large-scale, intelligent game for language learning. In: Artificial Intelligence in Education. Amsterdam: IOS Press.

Kirkpatrick, D.F. 1994. Evaluating Training Programs: The Four Levels. San Francisco: Berrett-Koehler.

Meron, J., Valente, A. and Johnson, W.L. 2007. Improving the Authoring of Foreign Language Interactive Lessons in the Tactical Language Training System. SLATE Workshop on Speech and Language Technology in Education.

O'Neil, H., R. Wainess, R., and E. Baker, E. 2005. Classification of learning outcomes: evidence from the computer games literature. The Curriculum Journal. 16 (4).

Surface, E., E. Dierdorff, and Watson. 2007. Special Operations Language Training Software Measurement of Effectiveness Study: *Tactical Iraqi* Study Final Report. Special Operations Forces Language Office, Tampa, FL, USA.

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Dr. Andre Valente co-founded Alelo Inc. while he was deputy leader of the Tactical Language project at the Information Sciences Institute of the University of Southern California. He joined our company full time in 2006. He has over 20 years of experience in management, technology development, and research in knowledge-based systems, ontologies, and intelligent teaching systems. His career includes managing numerous engineering and operations teams for manufacturing, media, aerospace and e-business companies. Dr. Valente holds a Ph.D. in computer science from the University of Amsterdam and an M.B.A. from the University of Southern California.

Robert Heuts is a researcher in the field of interactive media. He developed the TLTC Mobile prototypes for the Sony PSP and Windows Mobile, and has created several other education-related applications. These include a Student Information System now used by several schools in the Netherlands, and a MediaBase, which is a web-based front end to a large database containing all kinds of media (pictures, audio, video) stored into several separate physical databases. Prior to joining Alelo, he founded a software and hardware company that worked on applications for mobile phones. Mr. Heuts has a Masters Degree in Human Media Interaction focusing on design and computer interaction (AI, speech and language processing) from the University of Twente and a B.S. in Multimedia Design & Technology from the Saxion Hogeschool Enschede.

Glossary of Hawaiian terms

Hilo	Name of a Polynesian navigator
Hoahu	Warehouse
Honua	World
Hua (hua'olelo)	Word
Keaka	Theater
Kona	Big island
Lapu	Ghost ("unreal")
Paheona	Art
Uku (ukulele)	Flea
Waihona	Library
Wele (punawelewele)	(spider) Web