Constructing Virtual Role-Play Simulations

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INTRODUCTION

Virtual Role-Play Simulations are interactive simulations in which learners perform roles similar to what they would perform in real life. They are populated with virtual role players, i.e., non-player characters that fill out the roles in the simulation and interact with learners much as people typically do in real-life situations. Virtual role play is an important category of training that is particularly well suited to interpersonal skills. It has been applied to foreign language education (Johnson, 2010), cross-cultural skills training (Johnson et al., 2011), negotiation skills training (Kim et al., 2009), motivational interviewing (Radecki et al., 2013) and other clinical skills. Role-play scenarios are employed in sales and customer service training (Simmons, 2010). The impact of virtual role play is likely to grow as easy-to-use tools for creating such simulations become more widely available. It thus has a potentially important role to play as part of generalized intelligent frameworks for tutoring.

Virtual role play is inspired by training with live role players. In the military it is common to employ people as role players in training exercises, acting as civilians and combatants; ,for example, see Wilcox (2012). Such training can be highly effective but unfortunately the costs involved in employing role players and the logistics involved in staging live exercises limit their use. Sometimes military members must play supporting roles in these training exercises, acting as foreign civilians or opposing forces, so they are supporting the exercise instead of receiving training themselves. Medical education also makes use of live role players in the form of standardized patients, actors trained to behave as if they have a particular medical condition (Barrows, 1993). Such training can be valuable but is limited by the availability of suitably trained actors. Role play is also very common in sales training (Robinson, 1987), but trainees often do not like it because it is not conducted in a way that is supportive and conducive to learning (Sandler Training, 2014). Best practices call for sales managers to role-play the customer in such training episodes; this limits role play to times when busy sales managers are available to engage in training sessions.

Some researchers are seeking to make role-play training more convenient by moving interaction with live role players into virtual worlds. For example the Otago Virtual Hospital lets learners practice their clinical skills in a virtual world, interacting with simulated patients played by clinicians (Loke et al., 2012). Such training offers added convenience but it still depends upon the availability of skilled role players to control the patient avatars in the virtual world. Virtual role play with virtual humans has no such constraint; trainees can practice as much as they want, whenever they want.

Alelo has been heavily involved in virtual role-play training since its inception. It draws on an extensive body of research in supporting technologies such as pedagogical agents (Johnson & Lester, in press). The development team at Alelo has broad experience in creating virtual role-play content for a variety of user groups. For example Alelo's Virtual Cultural Awareness Trainers (VCATs) have been developed to teach about culture in over 80 countries. Users of Alelo courses number in the hundreds of thousands. This gives us practical insights into the issues involved in creating, validating, and delivering virtual role-play training at scale.

This chapter provides an overview of the key capabilities of virtual role-play training systems, using deployed training systems as examples. This will motivate the requirements for authoring tools. This is followed by a discussion of authoring processes for creating and validating virtual role-play content.

Authoring tools should be designed with these processes in mind. Next is an overview of available tools for authoring virtual role-play content. These include tools for creating simple role-play scenarios, tools for authoring complex role-play simulations, and emerging tools that empower trainers to construct and customize role-play training content themselves. Finally there is a discussion of future directions for this work and its implications for the Generalized Intelligent Framework for Tutoring (GIFT).

EXAMPLES OF VIRTUAL ROLE-PLAY TECHNOLOGIES

Figure 1 shows two example usage scenarios for virtual role play. These particular examples are intended to help learners develop their Chinese conversational skills. A common use case is shown on the left, where the learner has an on-screen avatar who interacts with on-screen virtual role players. If the user's computer or mobile device supports speech input, as in this example, the training system can employ speech understanding technology so that the virtual role players understand what the learner says and respond accordingly. This results in an engaging, immersive experience in which learners must apply their communication skills much as they would in real-life situations.

Figure 1. Learners can participate in a virtual role-play exercise by speaking and choosing actions for an on-screen avatar (left) or speaking directly with the virtual role player (right).

Advances in sensor technologies make it possible for learners to interact directly with virtual role players, instead of through an avatar. When integrated into lifelike robots, as in Figure 1 right, the virtual role player can interact with learners in the real world. This increases the realism of the role-play experience, particularly if the interface incorporates proximity sensors and gesture recognition to support mixed-initiative multimodal communication. In practice similar software architectures can be used in both cases to control the virtual role players.

Mobile devices are also increasingly attractive as platforms for virtual role play (Johnson et al., 2012). Advances in the computing power of mobile devices make it possible to deliver interactive virtual role players on tablets and smart phones, for anywhere, anytime training. Mobile devices are increasingly equipped with cameras and other sensors that facilitate natural interaction between learners and virtual role players.

TECHNIQUES FOR EFFECTIVE USE OF VIRTUAL ROLE PLAY

When used properly virtual role play offers a training experience that is realistic and similar to real-life interaction, but is in many ways actually superior to practice in real life. The example shown in Figure 2, taken from Alelo's VCAT Taiwan course, is a case in point. Here the learner is playing the role of an

American officer on assignment in Taiwan. The learner has been invited to a formal banquet hosted by his Taiwanese counterpart. It is important that the learner make a good impression and avoid doing something embarrassing or culturally inappropriate. For example, many toasts tend to be exchanged at such dinners. How can one follow proper etiquette for exchanging toasts without getting drunk in the process? Virtual role play offers an alternative to learning the hard way by making mistakes in real-life high-stakes situations. In this example the learner's avatar, on the left, has offered a toast saying "Drink as you like." This gives the learner the option of offering the toast with his teacup instead of a shot glass, as his host on the right does. If the learner says or does something inappropriate the virtual role players will react to it, so learner can see the consequences of his mistakes. But since the training module is just a simulation the negative consequences of mistakes are minimal. The learner can practice multiple times until she becomes comfortable saying and doing the right things at the right times. Alternative training media such as guidebooks may give learners a general understanding of the culture but do not help learners acquire the skills they need for such situations.

Figure 2. Virtual role play lets learners practice high-stakes interactions in a safe environment.

The following are some techniques for employing virtual role play that maximize its effectiveness. Authoring tools and technologies for virtual role play should support these techniques, to help developers and trainers make best use of this innovative instructional technology.

Intelligent tutoring technology, in the form of virtual coaches, can monitor learner performance in role-play simulations, provide feedback, and ensure that learners draw the right lessons from the practice experience. Figure 3 illustrates the VCAT's Virtual Coach, Erika, in action. In this example the learner has expressed dislike for a dish that sounded unappealing, namely sea cucumber. The Virtual Coach advises the learner to show appreciation and interest in the dishes that his host has offered. Such feedback can be very important in cross-cultural communication, where learners sometimes are not even aware when they make cultural mistakes.

When tasks become particularly complex, involving a variety of skills, it can be beneficial to break a task a part into component skills and role-play them separately, in a part-task training approach. VCATs and other Alelo courses utilize this approach to reinforce individual communication skills, as shown in Figure 4. Here the learner is practicing offering compliments to his host. Learners can practice individual responses by selecting from menus of options, as in this case, or speaking their response into a microphone.

To encourage ongoing practice and provide an appropriate level of challenge, simulations can be made to vary both in terms of amount of scaffolding and degree of difficulty of the interactions. The Tactical Interaction Simulator (TI Simulator) (Emonts et al., 2012) illustrates both dimensions of variability, as shown in Figure 5. The avatar in these examples is an Australian soldier on a peacekeeping mission in East Timor. The screenshots in the figure illustrate two different simulations of a clearance operation, in which the learner is supposed to keep civilians clear of hazardous areas. In the left screenshot the learner is provided with a high degree of scaffolding, including a transcript of the dialogue, possible courses of action, and possible ways of expressing these courses of action in Tetum (the language spoken in East Timor). In the example on the right the scaffolding is removed and the learner is expected to engage in conversation unassisted.

Figure 3. A Virtual Coach provides scaffolding and feedback on the learner's performance.

Figure 4. Learners can practice individual communication skills in a part-task training approach.

The left example, in which the civilians are hostile, is at a low level of communicative difficulty – all the learner can do in this case is to tell the civilians to calm down and to call the police. The right example, in which the civilian is initially cooperative, is linguistically more difficult – the learner must explain calmly why the civilian cannot enter the restricted zone and avoid raising tensions. These examples illustrate how virtual role-play simulations, if designed properly, can support learners at a variety of skill levels and encourage learners to practice and try alternative courses of action until they have fully mastered the target skills.

Figure 5. The Tactical Interaction Simulator can be played at a low level of difficulty and a high level of scaffolding (left), or a high level of difficulty and a low level of scaffolding (right).

These examples also illustrate that virtual role play involves nonverbal communication as well as verbal dialogue. The body language of the virtual role players can communicate their emotions and attitudes in ways that their verbal responses may not. Conversely virtual role play can enable learners to practice their nonverbal communication and use of body language. If the computing device has suitable sensors it can track the learner's body language directly. If not, the learner can use menus or interface gestures to control the body movements of his avatar.

Virtual role-play simulations can serve multiple purposes and phases of training: walkthroughs, practice, and assessment. In walkthrough scenarios the learner may have little or no mastery of the target skills and so the system provides a high degree of scaffolding and helps the learner walk through the scenario to get a feel for how to perform the task. The left screenshot in Figure 4 is an example of such a walkthrough – you don't need to know much Tetum to complete this simulation, although the score you receive depends upon how much Tetum you use. Practice simulations help learners develop their skills and involve progressively less amounts of scaffolding and higher levels of difficulty. In assessment simulations scaffolding is withheld and learners must demonstrate that they can complete the task unassisted.

In summary, below is a list of desirable characteristics for virtual role play, as illustrated in these examples.

- Engaging, immersive experiences that simulate real-world interactions.
- Support for multiple computing devices and interface modalities.
- Support for speech recognition and other sensors for more realistic interaction.
- Nonverbal as well as verbal communication.
- Alternative courses of action, to promote replayability.
- Support for walkthroughs, practice, and assessment.
- Virtual coaching support.

- Part-task training of component skills.
- Varying levels of scaffolding.
- Varying levels of difficulty.

ROLE-PLAY TRAINING AND SCENARIO-BASED TRAINING

Virtual role-play training is a related to scenario-based training. Scenarios and stories are used widely in training, and authoring tools are available to support their development. However scenarios in general are much simpler than virtual role-play simulations, and so are the authoring tools used to create them.

Figure 6 shows an example scenario created by Van Nice (2014), created using Articulate Storyline (Articulate Global, 2015). In this approach to scenario-based training, each character in the scenario appears as a drawn or photographic character, in a sequence of still poses. The non-player character poses a question, presented on the screen. The learner chooses from a small set of multiple-choice answers. The non-player character then responds to the learner's choice, and the system gives feedback on that choice.

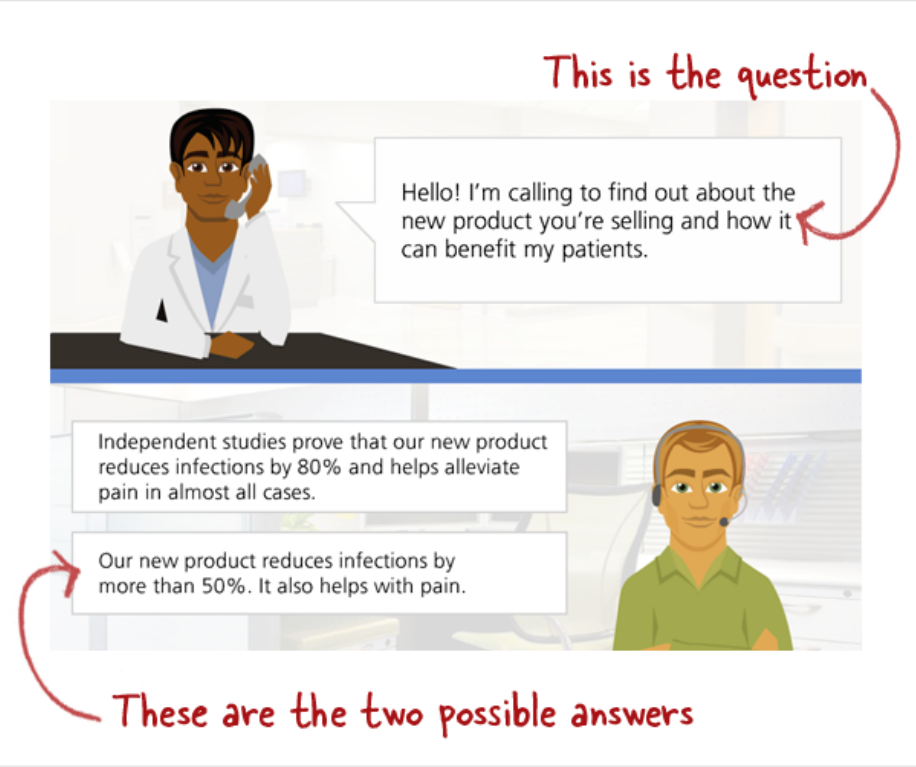

Figure 6. This example scenario was created using the Articulate Storyline authoring tool.

Scenarios such as this are useful for some purposes such walkthroughs. Current authoring tools make it possible to create such scenarios without any programming. However they lack many of the characteristics discussed in the previous section, and this limits their utility. In particular scenarios tend to limit learners to a small set of choices, as in this example. They are limited to a single question-response pair, as in this case, or a linear sequence of inputs and responses. This limits their replayability. Simulations in contrast support a range of possible inputs, responses, and outcomes, and so are more suitable for ongoing practice and sustainment. The challenge for role-play authoring tools is to make it easy to create such simulations with little or no programming.

AUTHORING PROCESSES

Authoring virtual role play is not simply the application of a tool; it is a process. It can involve multiple stages, with different participants involved at each stage. This is true for any significant intelligent tutoring development effort but it is especially true for virtual role-play authoring, because it can involve people with different skill sets. Authoring tools must be designed to support the intended process, participants, and roles.

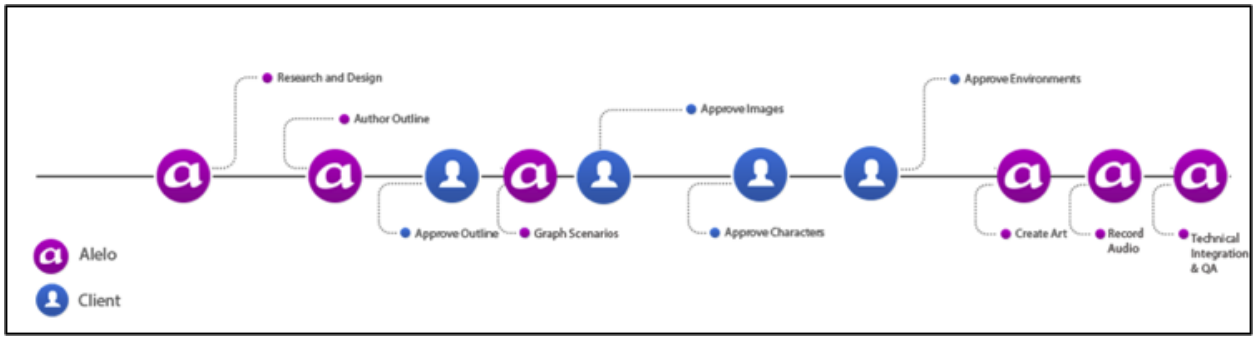

Figure 7. This example authoring process involves multiple phases and roles, both for the system developer and for the client.

Figure 7 shows one example development process, used to develop VCAT courses. Development proceeds in six distinct phases, from background sociocultural research through instructional design, scenario authoring, media production, and quality assurance. Each phase of authoring involves distinct activities and skill sets, and consequently different authoring capabilities. The course also goes through an approval process with the client, which also involves multiple phases. Authoring tool features can vary depending upon the stage.

Below are examples of some process issues that a good virtual role-play authoring toolset should support in order to create product-quality virtual role-play training systems:

- **Domain model validation.** The role-play simulation must reflect an accurate understanding of how the target skills are performed in real life. This is important when the training author and the subject matter experts are different people, or when multiple subject matter experts are required. Otherwise there is a risk that the course author will create content that appears to be correct but in fact is inaccurate. This is a critical issue for cultural awareness courses such as VCATs, which incorporate expertise in culture as well as military operations. For VCATs we cross-validate cultural content from multiple sources, to ensure that the final content correctly reflects the target culture.
- **Team collaboration and workflow.** Role-play simulation development often requires multidisciplinary teams. Authoring tools should support sharing among team members.
- **Courseware quality assurance.** The tools should support thorough testing and validation, to ensure that the resulting content is free of mistakes. Again, VCATs provide a good case in point. Errors can creep in in the domain model, the instructional design and content, in the artwork, and in the interaction behavior.

VIRTUAL ROLE-PLAY AUTHORING TOOLS

At the present time few authoring tools are generally available for creating virtual role-play simulations. Virtual role-play developers such as SIMmersion (2013) and Kognito Interactive (Boyd, 2015) create simulations using in-house tools and methods; they do not make these tools available to others and

publish few details about them. Scenario editors such as Articulate Storyline (Articulate Global, 2015) and Video RolePlay (Rehearsal Video Role-Play, 2015) make it easy to create simple scenarios but are not designed to support the creation of rich role-play simulations.

Page-based authoring tools

Most scenario authoring tools use a page metaphor, similar to slides in PowerPoint. The author creates a set of pages, where the virtual role player and learner's dialogue choices are bits of artwork embedded in the page. The dialogue progresses by jumping from page to page.

SkillStudio, the authoring toolset offered by Skillsoft, has support for creating role-plays (Skillsoft Ireland Limited, 2013). SkillStudio does not give users the option of creating new role-plays, but it permits users to edit existing role-plays developed by Skillsoft.

Skillsoft role-plays are composed of pages showing an image of a character saying something to the learner and a list of multiple-choice responses to select from, similar to the example in Figure 6. SkillStudio supports single-path role-plays and multiple-path role-plays. In single-path role-plays there is only one correct choice in each turn of the role-play, and learner is constrained to follow the correct path. In multiple-path role-plays each choice leads to a new dialogue page, each of which in turn leads to a set of successor pages. This results in a tree of pages. Skillsoft role-plays can be played in either Explore Mode or Summary Mode. Explore Mode is a kind of walkthrough mode in which the learner can explore the outcome of each option before making a choice. Summary Mode is a kind of assessment mode, in which the learner must make an immediate choice at each step in the role-play. Learners receive a cumulative score based on number of correct choices they make over the course of the role-play.

One limitation of the Skillsoft approach is that it offers the learner a limited range of options at each decision point. Each learner action is selected from a small list of choices, so learners learn to recognize appropriate responses instead of coming up with their own responses. Single-path role-plays constrain learners to follow a linear script. Multiple-path role-play trees offer more options, but they are not scalable. The number of pages is exponential in the depth of the tree. Realistic role-plays involving a series of conversational turns and a range of options become very large and time-consuming to produce.

ZebraZapps (Lee, 2013) is a more recently released authoring tool that supports the creation of role-plays as well as other interactive eLearning media. As in SkillStudio authors can author role-plays by creating a set of pages showing a picture of a character saying something and a set of multiple-choice options. The author can specify go-tos between pages, so that when the learner selects a choice it causes the course to jump to another page. The properties of graphical objects in the page, as well as the go-tos between pages, are presented in a table, to facilitate editing.

ZebraZapps role-play applications do not require quite as many pages as SkillSoft role plays, since authors can use go-tos to merge paths and share pages across paths. But since each simulation state is a separate page dynamic simulations inevitably require large numbers of pages. Large numbers of go-tos result in complex control structures that are hard to follow and difficult to maintain.

Dialogue authoring tools

Dialogue authoring tools differ from the above tools in that there is an explicit model of the dialogue that the character is engaging in, independent of the screen artwork. Dialogue authoring tools are designed to enable authors to define complex dialogues with interactive characters. Some dialogue authoring tools are emerging that are designed specifically to create role-play simulations.

ChatMapper (Urban Brain Studios, 2014) is a general-purpose authoring tool for nonlinear dialogue. Authors can create dialogue trees and specify conditions under which branches are activated. It can thus be used to create complex simulations. Dialogues are compiled into the Lua scripting language (Lua, 2014), a commonly used scripting language in games. The ChatMapper editor has a built-in conversation simulator, which makes it easy for developers to test dialogues as they are developing them. Although ChatMapper is very flexible, it only takes care of authoring dialogue logic. Constructing complete role-play simulations with capabilities listed above such as spoken dialogue, scaffolding, etc. inevitably requires additional Lua scripting and programming.

The USC Institute for Creative Technologies (ICT) has developed a series of experimental authoring tools for role-play development. For example the **Tactical Questioning authoring tool** (Gandhe et al., 2009) been used to create virtual role players for a system that trains tactical questioning skills. It supports a model of dialogue in which the virtual role player responds to questions posed by the trainee, and sometimes engages in subdialogues to negotiate with the trainee for compensation in return for the release of information. In this approach the author creates a model of information that the virtual role player knows and can talk about. This includes information about objects, people, and places. The author then defines dialogue acts that the player and virtual role player can engage in concerning this information. Dialogue acts include questions, assertions, offers, threats, offers, and insults, as well greetings and closings to start and end the conversation. Dialogue moves are specified as state transition networks, in which the author can specify conditions under which transitions may occur. Conditions may include the emotional state of the character and character's willingness to comply and cooperate, which in turn are influenced by what the learner has said previously in the dialogue. The system uses statistical language processing techniques for natural language understanding as well as natural language generation, to map between English text utterances and dialogue acts. The authoring tool enables the author to train the natural language processor by selecting which dialogue act to map to a given text utterance. Ghandhe et al. (2009) report that the developers used the Tactical Questioning authoring tool to create the first character, Hassan, after which two subject matter experts without previous experience building dialogue systems used the tool to author dialogue for two additional characters.

More recent ICT authoring tool named **SitPed** (Situated Pedagogical Authoring) utilizes the ChatMapper tool to create branching dialogue, and incorporates a character simulator so that authors can test and annotate dialogue as they create it (Lane et al., in press). It also provides authors a tool for annotating dialogue texts to indicate how well they exhibit the skills being taught in the simulation. An evaluation of SitPed was conducted in 2014, and at the time of this writing the results of this evaluation are still being analyzed.

Alelo has a suite of tools for creating training content employing virtual role play (Johnson & Valente, 2008). Alelo uses these in house, and also makes them available to third parties. For example the Danish Simulator (Dansksimulatoren, 2015), an award-winning game for learning Danish language and culture, was developed using Alelo's tools and platform. The toolset supports development teams throughout the authoring process, from background sociocultural research through building complete training systems. The tools and supporting methodology have enabled Alelo to deliver a wide range of effective culture and language training courses, which have a consistently high level of quality.

The core tools in the Alelo authoring toolset are **Xonnet** and **Tide**. Xonnet supports Web-based authoring by teams of authors, operating on content stored in a central learning content management system. It provides content management functions necessary for collaborative authoring such as checking in and checking out of content. Tide is used to design and construct the virtual role-play content elements within each course. Other tools in the toolset edit and manage the media assets comprising simulations, such as character animations and voice recordings. Content is specified in a device-agnostic fashion so that it can

run on personal computers and mobile devices, in Web browsers, immersive games, mixed-reality environments, and even mobile robots. For each hardware/software configuration Alelo has developed a content player capable of delivering content on that device and software platform.

To understand how authoring works one needs to know something about how the Alelo architecture controls the behavior of virtual role players (Johnson et al., 2012). Each virtual role player has a "brain" (decision engine) that controls a "body" (character persona and sensing-action layer) that operates within the simulated world or real-world environment. When the virtual role player is interacting with a trainee, the sensing-action layer receives inputs from the speech recognizer, user interface and other sensors, and virtual-world simulation, and relays them to the decision engine to determine what the character should do in response. The decision engine interprets the inputs in the context of the culture, current situation, and dialogue history, to determine what *act* the trainee is performing. Acts are similar to the dialogue acts in Ghandhe et al.'s (2009) formulation, but also subsume nonverbal communication and other actions. For example in the VCAT Taiwan simulations the trainee's avatar might extend his hand in order to share hands or raise his glass to offer a toast. The decision engine interprets such behaviors as acts with communicative intent and chooses an action to perform in response. The decision engine is able to recognize a variety of possible acts, affording the trainee a range of possible courses of action. The decision engine then chooses what action to perform in response, and realizes that as a combination of speech and gesture for the sensing-action layer to perform.

Each virtual role player model can incorporate a set of dynamic variables that represent the attitudes of the virtual role player toward the trainee. Trust and rapport are typically the most important variables. These can change over the course of the encounter in reaction to the trainee's actions, and can influence what actions the virtual role player will take. In many of the simulations Alelo creates the trainee must first establish trust and rapport in order to accomplish her mission.

The job of Tide is to enable authors to create content that conforms to this architecture, that enables the virtual role player to interpret the trainee's actions, and that responds accordingly. For each encounter or scene authors create an act library, which is the inventory of acts that the trainee or the virtual role player may perform during the encounter or scene. These can vary from simulation to simulation, but in practice authors reuse elements of previous act libraries when developing new act libraries. Authors also create utterance libraries, which consist of example utterances that express the meaning of the acts in the target language. To increase the coverage of utterances in the utterance library authors can use a templatizer tool, based on the work of Kumar et al. (2009), to generalize utterances into utterance patterns that match a variety of utterances.

Tide provides an interactive diagramming tool for specifying interactive dialogues. Dialogues are depicted as directed acyclic graphs containing nodes representing acts, utterances, and nonverbal behaviors. Transitions may be conditioned on certain predicates becoming true, e.g., a character's trust level exceeding a certain threshold. Authors can also create subdialogues that are activated and deactivated during the course of the dialogue. Through these simple mechanisms authors can create complex dialogues with a variety of alternative paths. A testing function enables authors to execute a dialogue within the editor, to validate the dialogue logic. This helps with the problem of quality assurance of the simulation content.

As authors create dialogues they incorporate assessment and feedback. Learner responses are scored and contribute to an overall assessment of the trainee's performance in the simulation. Some feedback, what we call *organic feedback*, is incorporated into the responses of the virtual role player and thus becomes an organic part of the simulation. For example the virtual role player might take offence at the trainee's statement or display facial expressions that indicate discomfort or disapproval. Such feedback is powerful and effective because learners can immediately see the consequences of their actions. Other feedback

takes the form of corrective and explanatory feedback to be provided by the Virtual Coach. The author supplies the feedback at authoring time, and it is up to the run-time content player to determine whether to present that feedback to the learner, based upon the chosen level of scaffolding or upon learner request.

Alelo tools are used to create role-play simulations that serve as walkthroughs, practice sessions, or assessments. They include single conversational turns for part-task training, as well as extended exchanges of several minutes in duration. Hundreds or even thousands of simulations have been authored to date using these tools.

EMPOWERING TRAINERS USING ROLE-PLAY CONFIGURATION TOOLS

Current dialogue authoring tools reduce the amount of programming required to create role-play simulations. However to promote adoption of the virtual role-play approach at a really large scale, it is important that we empower trainers so that they can create their own virtual role-play simulations. This goal of empowering trainers is one of the next big challenges for adaptive intelligent tutoring systems generally, including the tools described in this volume. Visionaries such as Sottilare (2013) have called for interfaces to intelligent tutoring systems that teachers and instructors can use. However there are just a few instances to date, such as ASSISTments (Heffernan & Heffernan, 2014) that teachers or trainers have used to any significant extent to create their own content. Alelo has developed a new product named VRP® MIL (Stuart, 2014) that is specifically designed to meet this need in the area of virtual role play.

VRP MIL was developed to meet the needs of military training organizations that wish to organize training exercises for their units at simulation training centers. Simulation training centers are equipped with computers for virtual training and staffed with personnel who are skilled in running training exercises using this equipment. The simulation center staff is permanently resident at the training center, while the units continually rotate through the center as part of their preparation for deployment.

When a unit wishes to organize a training program, the training officer associated with the unit typically works with the simulation center staff to define a series of training exercises for the unit to perform. The training officers are experts in training but may have little knowledge of simulation technology. It is up to the simulation center staff to quickly put together training simulations that meet the training officer's requirements. A common request from the training officer is training scenarios at varying levels of difficulty. The training officer might start with a training exercise at a high level of difficulty knowing that the trainees will likely fail the exercise, and to motivate the trainees to improve. The trainer will then undertake another exercise at a low level of difficulty, which the trainees will likely succeed in. They then undertake additional exercises at progressively higher levels of difficulty, until the exercises again reach a high level of difficulty. By this point the trainees have progressed to the point where they can successfully complete the mission, will full confidence in their skills.

When the training is preparation for overseas deployments a key challenge is providing training that accurately reflects the culture of the region of deployment. Unfortunately the training officers and simulation staff may not have detailed knowledge of the target culture. Cultural subject-matter experts, if they are available, may not have much knowledge of military missions or simulation technology. Moreover, if they are available they may not have accurate knowledge of the culture of the specific region; if they have been out of the country for an extended period their knowledge may not be up to date.

VRP MIL helps trainers and simulation staff to overcome these challenges and quickly create training simulations that are culturally accurate and appropriate for the intended training objectives. It provides trainers with a library of reusable virtual role players, each intended to perform a designated role in training simulations. Example roles include local leaders, guards and sentries, shopkeepers, and passers-

by on the street. Instead of authoring content from scratch using authoring tools, trainers populate the virtual training world with virtual role players and configure them to meet their needs. The behavior of each virtual role player has been validated beforehand as culturally accurate, ensuring that the resulting training simulation is also culturally accurate. VRP MIL is built as a plug-in that integrates into the popular VBS simulation-based training tool (Bohemia Interactive Simulations, 2015), which already provides users with tools for constructing virtual worlds and populating them with buildings, vehicles, and other entities.

We have developed the VRP MIL framework and a basic library of VRPs, and now plan to extend it with form-based interfaces for providing the necessary configuration parameters. Configuration parameters will include the level of difficulty interaction with the VRP, as well as specific topics that the VRP is prepared to discuss with the trainee. This fits well with the way the military currently defines roles for live role players in training exercises. These configuration parameters will then be automatically inserted into the dialogue model to generate the target behavior. Authoring tools will still be used to create the VRP models, but this way each VRP model will undergo much broader use. Simulation center staff will have the option to use the authoring tools themselves to add adapt and extend the VRP library.

VRP MIL underwent a successful trial evaluation in February 2015 at the NATO Joint Force Training Centre in Bydgoszcz, Poland, with NATO units preparing to travel to Afghanistan on training and support missions. From there we anticipate its adoption by NATO member nations and allied nations preparing for overseas coalition operations.

CONCLUSIONS AND FUTURE DIRECTIONS

Virtual role play is becoming an increasingly important training method for intelligent learning environments. It is being applied to an ever-broadening range of education and training applications, particularly for cross-cultural communication. Progress in authoring-tool development for this class of applications has made this possible. Emerging developments such as role-play configuration tools are likely to further accelerate the expansion and large-scale adoption of this technology.

Dialogue authoring tools for role-play simulations are in some ways similar to tutorial dialogue authoring tools such as AutoTutor's authoring tools (Nye et al., 2014) or TuTalk (Jordan et al., 2007), and there is much that we can learn from these tools. However role-play simulations have their own unique characteristics that warrant their own class of authoring tools.

Role-play authoring tools have been most successful when they take into account the tasks and roles of the people using the tools, and the processes by which content is developed. This is an important general lesson for authoring tools for adaptive intelligent tutoring systems. The clearer understanding we have of our intended users the better a job we can do of addressing their needs.

As we have seen, existing page-based authoring tools are quite capable of creating simple role-play scenarios. These tools are very widely available, and many training developers are familiar with their use. Virtual role-play and associated tools are most likely to be adopted when they offer clear and compelling advantages over existing methods, especially in skill development, authentic assessment, and promoting behavior change. There is a general lesson here for authoring tools for the adaptive intelligent tutoring systems of GIFT. Researchers in adaptive intelligent tutoring systems often wonder why their technologies are not being adopted more widely. Existing authoring tools are quite capable of creating simple versions of various types of learning environments, and trainers are unlikely to switch to new tools if they do not see a compelling advantage.

The general architecture for GIFT, as described in (Sottilare, 2012), needs to be clarified so that it accommodates the instructional interaction typical of virtual role-play simulations. According to the GIFT architecture the tutor-user interface and the training app client are separate, and interact with users separately. However as we have seen assessment and feedback are often tightly integrated into virtual role-play simulations, and feedback is an organic part of virtual-role-player behavior. If the GIFT architecture is to support virtual role play it should support such integrated interaction.

Virtual role-play systems can collect valuable, accurate data about trainee performance. There is an opportunity to capture and exploit this data as part of the GIFT architecture. One way of doing this via the TinCan API. Once data is captured via TinCan and stored in a Learner Record Store (LRS), it is possible to analyze these data and develop more granular models of learner skills, which in turn can be used to tailor training. If these are integrated with job performance data it would provide a method for providing just-in-time training and promoting behavior change on the job.

There is a need in virtual role-play systems for flexible domain models of dialogue that can be used in a variety of ways. In live role-play training exercises it can be useful to switch roles, so that the trainee can better understand the perspective of the other person. For virtual role-play systems to have similar flexibility they require dialogue models that capture the interaction while being agnostic as to which roles are played by the learners and which are played by the virtual role players. This is very consistent with the GIFT approach of modeling domain expertise independent of specific instructional use.

Looking ahead, speech recognition will continue to improve. Sensor and interface technologies will increase in performance and reduce in cost. This will make it easier to deliver virtual role-play training and assessment in a wider range of domains, to a wider range of organizations. Techniques that have been developed and proven in military training can be applied to a wide range of domains in training, development, and behavior change, for a wide range of organizations. Many of these currently rely on traditional methods and informal observation of performance. There are many opportunities to achieve radical improvements in training and performance development, through virtual role-play methods that employ realistic models of skill and provide accurate assessments of performance.

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REFERENCES

Articulate Global (2015). Storyline 2: Create interactive e-learning, easily. Retrieved Feb. 19, 2015 from https://www.articulate.com/products/storyline-why.php.

Barrows, H.S. (1993). An overview of the uses of standardized patients for teaching and evaluating clinical skills. *Academic Medicine, (1993),* 443-451.

Bohemia Interactive Simulations (2015). VBS3: The future battlespace. Retrieved Feb. 19, 2015 from www.bisimulations.com/virtual-battlespace-3.

Boyd, P. (2015). Dooplo - Kognito's human interaction platform. Retrieved Feb. 19, 2015 from http://patboyd.com/site/projects/kognito-platform.

Dansksimulatoren (2015). Dansksimulatoren – revolutionizing language learning. Retrieved Feb. 19, 2015 from www.dansksimulatoren.dk.

Emonts, M., Row, R., Johnson. W.L., Thomson, E., Joyce, H. de S., Gorman, G., & Carpenter, R. (2012). Integration of social simulations into a task-based blended training curriculum. In *Proceedings of the 2012 Land Warfare Conference*. Canberra, AUS: DSTO.

Gandhe, S., Whitman, N., Traum, D., & Artstein, R. (2009). An integrated authoring tool for tactical questioning dialogue systems. In *6th Workshop on Knowledge and Reasoning in Practical Dialogue Systems*, Pasadena, California. 2009. Retrieved Feb. 19, 2015 from http://people.ict.usc.edu/~traum/Papers/krpd09authoring.pdf.

Heffernan, N. & Heffernan, C. (2014). The ASSISTments Ecosystem: Building a platform that brings scientists and teachers together for minimally invasive research on human learning and teaching. *International Journal of Artificial Intelligence in Education 24*(4), 470-497.

Johnson, W.L. (2010). Serious use of a serious game for language learning. *International Journal of Artificial Intelligence in Education, 20*(2), 175-195.

Johnson, W.L., Friedland, L., Schrider, P., Valente, A., & Sheridan, S. (2011). The Virtual Cultural Awareness Trainer (VCAT): Joint Knowledge Online's (JKO's) solution to the individual operational culture and language training gap. In *Proceedings of ITEC 2011*. London: Clarion Events.

Johnson, W.L., Friedland, L., Watson, A.M., & Surface, E.A. (2012). The art and science of developing intercultural competence. In P.J. Durlach & A.M. Lesgold (Eds.), *Adaptive Technologies for Training and Education,* 261-285. New York: Cambridge University Press.

Johnson, W.L. & Lester, J.C. (in press). Twenty years of face-to-face interaction with pedagogical agents. *International Journal of Artificial Intelligence in Education*.

Johnson, W.L. & Valente, A. (2008). Collaborative authoring of serious games for language and culture. *Proceedings of SimTecT 2008*.

Jordan, P., Hall, B., Ringenberg, M., Cue, Y., & Rosé, C. (2007). Tools for authoring a dialog agent that participates in learning studies. In R. Luckin et al. (Eds.), *Artificial Intelligence in Education*, 43-50. Amsterdam: IOS Press.

Kim, J.M., Hill, R.W. Jr., Durlach, P.J., Lane, H.C., Forbell, E., Core, M.G., Marsella, S. Pynadath, D.V., & Hart, J. (2009). BiLAT: A game-based environment for practicing negotiation in a cultural context. *International Journal of Artificial Intelligence in Education, 19*, 289-308.

Lane, H.C., Core, M.G. & Goldberg, B.S. (in press). Lowering the skill level requirements for building intelligent tutors: A review of authoring tools. In R. Sottilare, A. Graesser, Xiangen Hu, & K. Brawner (Eds.), *Design Recommendations for Adaptive Intelligent Tutoring Systems: Authoring Tools (Volume 3*). Orlando, FL: U.S. Army Research Laboratory.

Lee, S. (2013). Build a role play in a day with ZebraZapps. Retrieved Feb. 19, 2015 from http://vimeo.com/80417830.

Loke, S.-K., Blyth, P., & Swan, J. (2012). Student views on how role-playing in a virtual hospital is distinctly relevant to medical education. *Proceedings of ascilite 2012.* Retrieved Feb. 19, 2015 from http://www.ascilite.org/conferences/Wellington12/2012/pagec16a.html.

Lua (2014). Lua: The programming language. Retrieved Feb. 19, 2015 from www.lua.org.

Nye, B.D., Graesser, A.C., & Hu, X. (2014). AutoTutor and family: A review of 17 years of natural language tutoring. *International Journal of Artificial Intelligence in Education 24* (2014), 427-469.

Radecki, L., Goldman, R, Baker, A., Lindros, J., & Boucher, J. (2013). Are pediatricians "game"? Reducing childhood obesity by training clinicians to use motivational interviewing through role-play simulations with avatars. *Games for Health Journal, 2*(3), 174-178.

Rehearsal Video Role-Play (2015). Rehearsal features. Retrieved Feb. 19, 2015 from http://www.videoroleplay.com/features.

Robinson, L.J.B. (1987). Role playing as a sales training tool. *Harvard Business Review,* May-June 1987, No. 87310. Cambridge, MA: Harvard Business Publishing.

Sandler Training (2014). A better way to role play. Retrieved on Feb. 19, 2015 from http://www.sandler.com/blog/a-better-way-to-role-play/.

SIMmersion (2013). Technology: Ground-breaking technology lets SIMmersion deliver effective communication training to learners of all kinds. Retrieved Feb. 19, 2015 from http://simmersion.com/Technology.aspx.

Simmons, T.G. (2010). Using virtual role-play to solve training problems: How do you train employees to think on their feet? *eLearn magazine*, June 2010. Retrieved Feb. 19, 2015 from http://elearnmag.acm.org/archive.cfm?aid=1821985.

Skillsoft Ireland Limited (2013). Roleplays. Retrieved Feb. 19, 2015 from http://documentation.skillsoft.com/en_us/sstudio/index.htm#17853.htm.

Sottilare, R.A. (2012). A modular framework to support the authoring and assessment of adaptive computer-based tutoring systems. Paper presented at the Interservice/Industry Training, Simulation & Education Conference (I/ITSEC), Orlando, FL.

Sottilare, R.A. (2013). Pushing and pulling toward future ITS learner modeling concepts. In R. Sottilare, A. Graesser, X. Hu, & H. Holden (Eds.), *Design recommendations for intelligent tutoring systems*, 195-198. Orlando, FL: U.S. Army Research Laboratory.

Stuart, S. (2014). Using video games to prepare for the culture shock of war. *PC.com*, Nov. 24, 2014. Retrieved Feb. 19, 2015 from http://www.pcmag.com/article2/0,2817,2472395,00.asp.

Urban Brain Studios (2014). *Chat Mapper 1.7 documentation*. Retrieved Feb. 19, 2015 from http://www.chatmapper.com/documentation.

USC ICT (2013). Situated pedagogical authoring for virtual human-based training. Retrieved on Feb. 19, 2015 from http://ict.usc.edu/wp-content/uploads/overviews/Situated%20Pedagogical%20Authoring_Overview.pdf.

Van Nice, J. (2014). Toolbox Tip: Creating scenarios in Articulate Storyline – No programming necessary. Retrieved Feb. 19, 2015 from https://www.td.org/Publications/Blogs/Learning-Technologies-Blog/2014/08/Creating-Scenarios-in-Articulate-Storyline.

Wilcox, A. (2012). Somali-Americans assist reserve Marines with pre-deployment training. *The Daily News – Jacksonville, NC*, Dec. 13.

LIST OF FIGURES