The Virtual Standardized Patient
Simulated Patient-Practitioner Dialog for Patient Interview Training

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We describe the Virtual Standardized Patient (VSP) application, having a computerized virtual person who interacts with medical practitioners in much the same way as actors hired to teach and evaluate patient assessment, diagnosis, and interviewing skills. The VSP integrates technologies from two successful research projects conducted at Research Triangle Institute. AVATALK™ provides natural language processing, emotion and behavior modeling, and composite facial expression and lip-shape modeling for a natural patient-practitioner dialog. Trauma Patient Simulator provides case-based patient history and trauma casualty data, real-time physiological modeling, interactive patient assessment, 3-D scenario simulation, and instructional record-keeping capabilities. The VSP offers training benefits that include enhanced adaptability, availability, and assessment.

1. Introduction

Standardized Patients (SP's), sometimes called simulated patients, are actors who play the role of patients or actual patients coached to present specific illnesses to the medical practitioner. Their purpose is to teach and evaluate patient assessment and interviewing skills. At least 94 medical schools in the U.S. and Canada currently employ SP's in their teaching programs, and 26 U.S. medical schools cooperate in resource-sharing, standard-setting, and other issues relevant to implementing effective SP programs [1].

There are limits to how effective SP's can be for training. Given such concerns as actor training and availability, reproducibility, changing evaluation criteria, and implementation cost, we have begun development of virtual SP's as an alternative to hiring actors for teaching and evaluating patient interviewing skills [2].

Our approach to training is illustrated in Figure 1 (adapted from [3]); the approach holds for training technical skills such as maintenance and inspection as well as soft skills such as customer service and interviewing. We have found that for most skills, a combination of learning environments proves most cost-effective [4]. Specifically, providing students with a virtual learning environment enables them to become familiarized with materials, acquire and even practice their skills. This reduces the need for live equipment and on-the-job simulations (which are often costly, time consuming, and manpower intensive) to validation of skill performance.

Virtual learning environments can take many forms, depending on training requirements. For the present need, the environment demands a responsive, realistic, emotional, intelligent virtual patient with whom the practitioner can converse naturally. The Virtual Standardized Patient (VSP) application with AVATALK™-enabling meets this need.

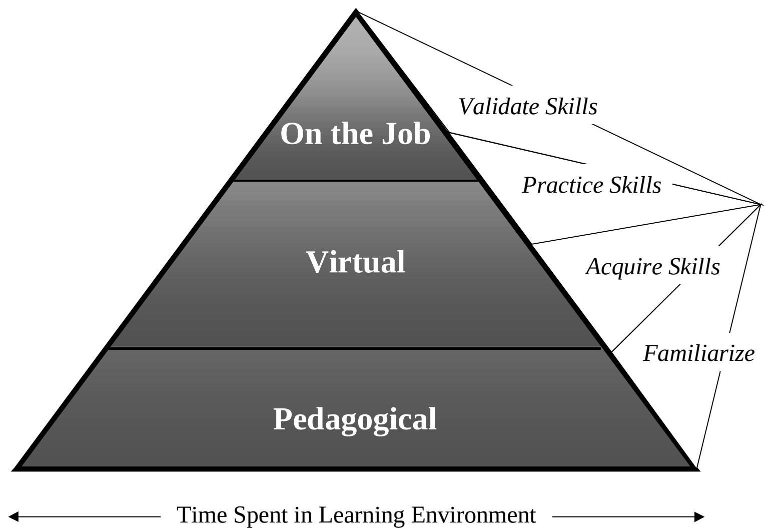

Figure 1. RTI Training Triangle

2. Design

The VSP integrates technologies from two research programs in advanced learning methodologies conducted at Research Triangle Institute (RTI). The AVATALK™ program provides natural language processing, emotion and behavior modeling, and composite facial expression and lip-shape modeling for a natural patient-practitioner dialog. Trauma Patient Simulator (TPS) provides patient history, real-time physiological modeling, interactive patient assessment, 3-D scenario simulation, and record-keeping for realistic physical examination [5].

The AVATALK™ application has already been used in customer service and survey interviewing training programs. The AVATALK™ suite of technologies involves:

- *Natural language processing* which incorporates the ability to recognize natural, unscripted speech and to understand speech based on the content of the discourse [6]. The application is designed to expect relevant, reasonable speech from the trainee, similar to that which occurs during regular conversation. As in regular conversation, expectations mature as conversation progresses.
- *Emotion and behavior modeling*. AVATALK™ virtual humans act realistically as if they are angry, depressed, serene, or in pain. Action takes the form of facial expression, lip synching, gesturing, choice of utterances, conversational expectancies, and branching logic within the application.
- *Dynamic virtual worlds* in which activities occur and contextual cues reside. Conversation does not take place in a vacuum; instead, the environment plays a large role in shaping conversational flow.

TPS has already been used in Emergency Medical Services (EMS) training programs. The TPS suite of technologies involves:

- *Trauma casualty simulation* that occurs in the context of a trauma scenario consisting of a scene (or setting), an incident that produces injuries, and one or more patients. The visual presentation is a 3-D virtual world that contains patients and other objects. Mechanisms-of-injury currently include falls, gunshot wounds, vehicle collisions, explosions, and blunt injury.

- *Physiological modeling*, providing continuous, real-time cardiovascular, respiratory, and pharmacological simulation. The patient exhibits medical signs and symptoms with real-time, true-to-life physiological behavior.
- *Interactive medical care*, enabling the caregiver to interact physically with the virtual patient, as, for example, taking a pulse. TPS takes the user through the sequence of trauma-patient assessment, beginning with entering and sizing up the scene, determining level of consciousness, checking the ABCD's, and attending to major life-threatening conditions.
- *Scenario configuration*, dynamic simulation software that combines, schedules, and manages the databases of patients, injuries, scenes, and critical incidents to create static and time-varying scenarios without developing new code.

Integration of these technologies provides for both natural patient-practitioner dialog and realistic patient assessment in the VSP.

3. Methods

We are able to demonstrate the VSP using well-established SP scenarios as used in the clinical setting for evaluating patients who have specific illnesses. For example, we will use criteria such as those developed for the evaluation of asthmatic patients [7]. We can also use the VSP for SP scenarios for teaching and evaluating broader concepts such as bioethics [8]. The VSP employs a simulation database: (1) to hold patient and scenario data; (2) to define the set of diagnostic testing and interactive care methods available to the practitioner; (3) to provide rules of simulation and interaction; and (4) to characterize responses (verbal, physiological, expressive, and behavioral) made by the virtual patient to the practitioner.

Conversation, where one or more individuals engage in an interactive dialog, is similar across disciplines, from patient-practitioner dialog to conducting surveys. The AVATALK Scripting Engine allows for the rapid creation of interview scripts that readily integrate into the AVATALK™ architecture. An interview template captures questions and responses, branching instructions, emotional feedback to responses, tutorial associated with responses, and other application-specific information. This information is fed into the database structure, from which are generated grammar files for natural language discourse, logic flow files that define behavioral and emotional effects as the conversation progresses, and interface components. The AVATALK Role Play Engine interprets all of these files as it runs the interview (Figure 2).

Physical examination is accomplished via the interactive 3-D environment. The patient is a 3-D virtual model with realistic attributes that exhibit medical signs and symptoms with real-time, true-to-life physiological behavior. Cardiovascular data, physiological trends, and body sounds (e.g., lung and heart sounds) give the user insight into the patient's condition, response to treatment, or failure to take appropriate action. Physiological responses to bleeding, pain, internal trauma, and hypoxia are realistic and can be modified by physical and medical interventions. The intrinsic airway resistance model, for example, can be used to modify bronchial air flow, and, in turn, manifest wheezing in the lung sounds.

We stress that, although the scenarios are pre-defined, the interaction itself is unscripted. The scenario establishes initial conditions, but the trainee's responses to the virtual patient, as well as inherent flexibility in how the virtual patient is allowed to react, cause the conversational flow to vary from interview to interview. Add to this versatility the ability to select virtual patients who differ in age, ethnicity, gender, and personality, as appropriate, and the VSP becomes a realistic learning application wherein the practitioner must learn to handle each patient individually.

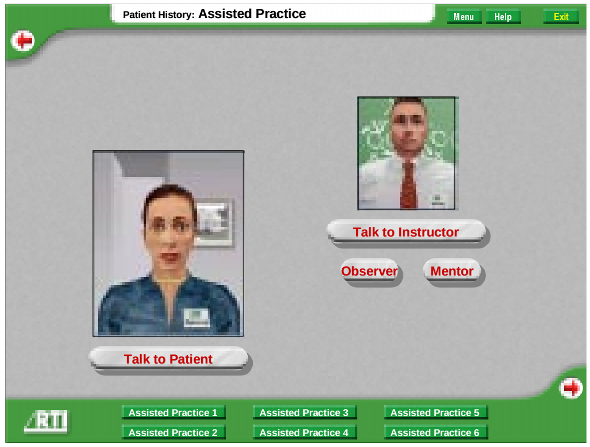

Figure 2. VSP User Interface

4. Results

The VSP is a concept demonstration and, as such, no formal assessment is presently available. However, assessment is underway on an AVATALK™-enabled survey interview application. We can point to the benefits that we have found from similar training approaches.

The VSP provides a computerized virtual patient who interacts with the medical practitioner in a similar way to the SP, yet is available 24/7 for practice. As shown in Table 1, the same roles of trainee, patient, observer, and coach that are required using SP's are also required using the VSP, but virtual persons obviate the need for a hired actor. In the actor's place, the virtual patient plays the role of patient while a virtual coach simultaneously observes and records the interaction, providing guidance and feedback when needed or requested. Observation and assessment become more robust and easier to control when these roles are automated.

The VSP has additional benefits in its adaptability, availability, and distribution. Characteristics represented by the virtual patient can easily be modified. For instance, gender, age, ethnicity, and physical features can be altered merely by swapping or altering virtual models. The models do not need to be photo realistic, so long as the student is also given critical contextual cues (e.g., sound, background images, environmental objects). Similarly, the virtual patient's personality, reactivity, expressiveness, and other behavior elements can be determined before use as well as dynamically during the course of training. Patient symptoms are also modifiable. For instance, the simulated patient's chief complaint may be changed from asthma to cardiovascular problems with the simple replacement of patient interview scripts.

The VSP software is usable and versatile. Its ease of use makes it ideal for both centralized or decentralized training. It is useful for initial training [9], refresher training [10], and ongoing assessment of interviewing skills. Because the software was designed to run on a relatively inexpensive laptop computer, it can be used on many home computers as well, with distribution via compact disc or a network.

5. Conclusions

In clinical settings, an effective patient-practitioner dialog provides the practitioner with full understanding of a patient's condition, enabling the practitioner to consider medical history, identify root causes of the illness, and implement an optimal course of action. These diagnostic interviewing skills are honed through repeated interactions with real or standardized patients [11].

The VSP provides an opportunity for students to practice numerous case-based scenarios in a reproducible, objective learning environment prior to the challenge of actual patient interaction.

Table 1. SP vs. VSP Training Approaches

Role	SP Approach	Player	VSP Approach	Player
Medical practitioner (i.e., trainee)	Student's ability to learn dependent on: • relevance of role-play scripts, • time available during training to conduct role-plays, • acting ability of actor, • observations made by actor and by instructor.	Student	Student's ability to learn enhanced by: • using numerous role-play scripts, • interacting with different virtual patients, • knowing that actions are observed and tracked.	Student
Patient	• Actor must act out a role that s/he will not always understand. • Actor is of a specific gender/age/ethnicity.	Actor	• Ability to simulate conditions impossible with a human actor. • Different virtual patients of gender/age/ethnicity and having different personalities.	Virtual human
Observer	• Actor must take on second role of Observer. • Second student is in passive learning mode.	Actor -or- Second Student	• Ability to track all interactions with virtual patients. • Knowledge of all characteristics of virtual patients.	Second virtual human
Coach/Tutor	• Instructor must rely on actor for assessment of Student when not actually witnessing interaction.	Instructor	• Virtual coach has ability to guide learning as it occurs. • Instructor can use automatically collected interaction information for assessment, as well as actually witnessing interaction.	Second virtual human Instructor

6. References

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