Lessons Learned in Embodying Tutoring for Interactive Skills

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Abstract
We describe intelligent virtual tutoring for interaction skills training. Our customizable intelligent tutors can serve as demonstrator, coach, trainer, mentor, and observer. These roles meet the needs demanded of tutors across stages of skill learning, stages that we've derived from distributed and standalone simulation-based individual training for procedural and interaction skills. Lessons learned regarding elicitation of instructional knowledge and performance measurement are discussed.

Keywords
Coaching, distributed training, interaction skills, intelligent tutoring, mentoring, remediation.

FAPV AND TUTORING SYTEMS

We've found it instructive to describe the stages through which students advance in mastering skills as *familiarization*, *acquisition*, *practice*, and *validation* (FAPV) [1]. Becoming familiarized with to-be-mastered skills implies gaining knowledge about components or events or procedures. Acquiring a skill is learning "school solution" or best-practice techniques and procedures, often in lock-step (i.e., vs. free-play) fashion. During practice students internalize techniques and procedures and learn strategic knowledge about their application, experiencing multiple scenarios with different 'fault' conditions. Validation tests students on their performance of skills to established standards within set conditions.

The literature suggests that tutors' roles change as students advance through stages in a simulation. Initially tutors transmit important information and demonstrate appropriate techniques, familiarizing relatively passive students. Quickly, students begin directing their own learning, and tutors act as facilitators, yielding control but reacting to differences between student actions and performance criteria. Tutors regulate FAPV stages as, for example, insufficient familiarization or practice may cause students difficulty in applying acquired skills. Eventually, students have acquired the skills and know-how to apply the skills, and tutors validate skills, and act as mentors for proficient students, prepared to provide guidance or feedback but refraining from interjecting absent an obvious error. Types of learning support provided include direct support (help functions, mentoring), encouragement to reflect to realize gaps in knowledge, and internal support (reducing task complexity, focusing attention).

We assert that good tutoring systems follow several principles all found in the literature. They provide scaffolding, gradually guiding students by providing decreasing support as knowledge and skills are gained in a planned fashion through case-based scenarios. They provide repeated practice on isolated skills with feedback linked to learning objectives, and collect critical-skill performance data based on student actions as evidence of competency. They identify trainable moments, that is, opportunistic events (based on student behavior) where just the right support will enhance learning. They target multiple level of learning, such as at behavioral, conceptual, and metacognitive levels. They include after-action reports detailing customer-defined performance measures for the critical tasks, showing session histories relating student actions against specific performance criteria. And they embed training within naturalistic environments.

To meet these principles, tutoring systems typically comprise three components. A *domain model* contains familiarization content, qualitative expert reasoning models, and meta-knowledge of typical student mistakes, misunderstandings, and misconceptions in naturalistic settings. A *tutor model* includes assessment and remediation strategies, representational knowledge, understanding of how to adapt to students, and performance measures. A *student model* captures students' ongoing mastery and deficiencies as well as learning motivators.

We define five tutor roles along a continuum of intrusiveness (or some similar construct). As *demonstrators*, tutors demonstrate best practices and step-by-step techniques. As *coaches*, tutors actively prompt and assist as the students perform, suggesting actions to guide students while remediating after actions. As *trainers*, tutors provide content-relevant help, with students largely in control, while frequently assessing knowledge to keep learning on track. As *mentors*, tutors monitor actions and only offer context-sensitive help or remediation or critique when necessary or requested. As *observers*, tutors observe and record and conduct after-action review involving playback and reflection.

INTERACTION SKILLS TRAINING

Much of our focus is on interaction skills training, such as interviewing, negotiating, and providing topical understanding. For interaction skills training, virtual human tutors are quite appropriate to lead to competency and mastery of skills. The realism of interacting with an emotive, responsive virtual human engages students. Enabling students to query virtual tutors, either during or after an interaction, allows strategic and reflective thinking that together produce stronger learning. Further, interaction skills training increasingly employs virtual humans as interactive partners [e.g., 2-3], hence virtual human tutors fit naturally with this design.

We advocate, at least for certain tutor roles, that students be granted control over some virtual tutor parameters (see Table 1). Controls are available for such parameters as level of support (a sliding scale rather than discrete choices), need for proactive guidance or reactive feedback, extent of review after each iteration of an interaction has completed, and even personality style. With virtual humans as tutors, these parameters are immediately accessible.

Table 1: Sample Tutor Control Parameters

Appearance:	Gender; age; ethnicity
Personality:	Humor; politeness; volatility
Role:	Level of support; record/playback the interaction
Application flow:	Timeout; scenario difficulty; minimum errors allowed; natural language reliability

SOME LESSONS LEARNED

We have developed several interaction skills training systems with virtual human tutors. In one application, students learn to obtain consent from a respondent to participate in a door-to-door survey. The tutor was given knowledge of correct/incorrect consent procedures and strategies for obtaining consent. In another application, students learn to conduct a patient medical history to determine underlying causes of respiratory problems. The tutor was given knowledge of types and causes of respiratory problems and understanding of sound questioning strategies.

Lessons learned from developing these interaction skills training systems, as well as otherwise unrelated web-distributed SCORM-compliant procedural training systems, include:

- Students are engaged with virtual human tutors and understand how tutors can take on the different roles. Embodying tutors increases their salience.
- The delineation and aggregation of student performance measures requires careful assessment of protocols and standards in the literature, and subject-matter expert input, as standards need to adjust for specific scenarios. Having realistic-enough simulations and tutoring requires rigorous expert or instructor input and review. These individuals can say whether or not the behaviors that students and tutors exhibit within the simulation accurately reflect the behaviors of students and instructors in live environments.
- Performance must be measured against defined criteria, and tutoring should focus students on need-to-know competencies, providing links to prescriptive training. Student actions are observed not only explicitly (e.g., tests) but also implicitly (e.g., tracked navigation, keystrokes, mouse movement, menu selection, and time). Simpler assessment such as use of established test items (e.g., pulled from existing course curricula) as measures of knowledge make interpretation of test results easy, but only for familiarization. More complex assessment by observing student behavior demands careful definition of performance criteria. Interaction skills often fail to have best-practice criteria, so designer and expert decisions drive assessment.
- SCORM concepts of terminal and enabling learning objectives may be extended to allow conceptual as well as procedural measures in support of identified performance measures. Also, each performance measure associated with practice of skills may be associated with variable criterion settings, rather than static, and tagged with links to remediation within familiarization and acquisition. These additions improve student modeling by taking into account not only behaviors but also reasoning behind behaviors, and theory behind the reasoning, to drive remediation.
- Results from knowledge and performance assessment link to remedial training. Results are useful if two conditions are met. First, any tests must be well constructed so that correct/incorrect responses can be assured of indicating areas of strength/weakness. Second, training must be designed modularly, so that remediation of or within specific lessons can occur, without students needing to repeat lessons for assessments that they passed. The process is iterative; students undergo only those assessments that they failed.

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