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Virtual Patients to Train Communication Skills of Healthcare Providers

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ABSTRACT

Virtual patients (VPs) offer an affordable and feasible method to train individuals when compared to patient-actors. They can provide training on communication skills, such as motivational interviewing and conflict resolution, and often facilitate a change in patients' thinking and emotional states. However, few studies have focused on VPs with cognitive and emotional states and internal schema or rules that govern them. In this research, we aim to design and empirically study a VP training system with a mental model to enrich the interactions and training. With such a model, the learning environment has the potential to generate valuable feedback and guidance for the learner based on the states of the VP. We started by examining systems aimed at training individuals with a virtual agent that simulates a person in a social situation (e.g., a virtual customer to train salespersons). We developed an architecture for these systems, defined the current interaction approaches, and will discuss the main aspects of the training system architecture and various technological approaches. Here, we consider the potential solutions proposed in adjacent virtual-agent domains. Based on our findings, we will model the VP's reasoning to improve trainees' communication skills and investigate how helpful feedback and guidance could be generated from these mental models at run time. The main contribution of our work will be the build of an empirically grounded virtual patient with a mental model as a training system.

CCS CONCEPTS

• **Human-centered computing** → **Human computer interaction (HCI)**; • **Applied computing** → *Interactive learning environments*; • **Computing methodologies** → **Intelligent agents**.

KEYWORDS

Virtual Patients, Virtual Agents, Communication Training, Training Simulation

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1 INTRODUCTION

Communication between healthcare providers and their clients is as essential aspect of the healthcare field. The Institute of Healthcare Excellence has reported that miscommunications between doctors and patients are responsible for around half of the medical errors that could be prevented [28]. Student doctors tend to be trained with standardized patients (i.e., actors who pretend to be patients), which would allow them to practice their skills without training on actual patients [16]. However, standardized patients pose limitations because of the higher cost of using actors, their availability, and the inconsistency between actors [19]. Virtual patients (VPs; i.e., virtual agents who mimic human help seekers in realistic scenarios) have the potential to overcome these limitations [23]. VPs can train health workers in communications with help seekers or colleagues [14], and have shown the ability to improve the users' communication [2]. Some examples include training student doctors on empathetic responses [6], de-escalation of aggressive behaviors [15], and shared decision making [11]. Several reviews have been aimed at classifying the various types of training agents in virtual settings (e.g., [2] and [14]). It is worth noting that the field of VPs has been studied more frequently in recent years. For example, whereas Scopus found for the term "Virtual Patient" 253 documents in 2012, in 2021 it found 942 documents, with an annual growth rate of 27.23% in this period.

VPs, however, are often limited in their cognitive capabilities, as designers usually map a specific input to a predefined response. Several architectures have been proposed to emulate the thinking and acting process for interactive agents, which can be categorized as cognitive architectures, affective models, and emotion models [21]. Such models have been implemented in other domains to enrich the interactions with the user (e.g., in robotics [20]). Although many architectures exist (e.g., Samsonovich et al. [24] listed 25 cognitive architectures), incorporation into VP seems rare, with a few exceptions, such as McShane et al. [17]. By including these models, a VP could base its current state (e.g., having a specific belief or emotion during interaction) on the way it perceives the world from the provided information. This has the promise of a more natural conversation flow and a better understanding of the agent's current state, as well as training conversation skills that aim to facilitate a change in people's thinking, attitude, or emotional

state. Furthermore, simulating agents' states can create positive educational gains for trainees, as it could show the agent's internal thought processes, such as showing the changes in their beliefs or emotions. Some initial attempts have been made to show this with a gauge that changes depending on the user choice input (e.g., trust meter [25]). Therefore, the main aim of the dissertation is to design and empirically study virtual patient training systems with reasoning capabilities to improve trainees' communication skills. We will do so by incorporating mental models into the VP to simulate a help seeker interaction process and generate feedback from such interactions.

2 APPROACH

To achieve our research objective, we started by examining interactive agent-based systems whose main aim is to train users on social skills in a simulated situation. Based on the literature analysis, we will build a training system that incorporates a VP with a mental model. Next, we focus on generating helpful training feedback based on mental models to guide the learners and help them to reflect on the effect of the interaction with a patient. With this in place, we will empirically study and conduct controlled experiments on the learning effect, trust and acceptance of the system, and feedback with potential trainees. We will preregister all studies on the Open Science Framework (OSF) ahead of data collection[1]. The anonymized collected data, alongside the programming code and statistical analysis, will be made available publicly where possible.

2.1 Prospective on Training Systems

As VPs utilizing mental models are rare, we extended our research to systems for social skills training in general that include agent-based systems that simulate interactions with a human to train them on social skills. Examples of such training systems concern job interviews [8] and negotiation skills [12] [27]. We planned to examine these training systems, where we have three primary goals : (1) propose a model that explains an agent-based training system's information flow, (2) establish an overview of the current interaction approaches between the user and the agent, regarding the essential aspects for a training system, and (3) suggest possible visions of what can be integrated and applied from the state-of-the-art research on virtual agents from other domains (e.g., possible data-driven approaches or emotional architectures), which are not yet used in social-skill training systems. The proposed model explains the structure of these systems, highlighting the primary elements. It also presents an integrated view of existing models for virtual agents and pedagogical agents. The model structure and elements are based on the reported architectures, general models for virtual agents [13] [18], architectures for tutoring systems [1] [4], and dialogue management architectures [7] [3]. Furthermore, we define five interaction approaches between the user and an agent (i.e., predefined, handcrafted, data-driven, and hybrid between the last two). Currently, we are working on discussing each approach and compare them to each other, focusing on five dimensions that are deemed essential for training systems. The dimensions are the action manager (i.e., how the agent decides its next steps), the agent model, the user model affecting the agent, the teaching strategies affecting the agent, and the provided feedback by the agent. This would be accompanied by our suggestions of what else could be integrated with a training system for future research possibilities. For the setup of the paper we intend to write, we have been inspired by the structure used in two dialogue management papers [7] [3].

2.2 Virtual Patient Reasoning

We aim to build a training system for improving the trainee's communication skills to facilitate change in a help seeker's attitude, cognition, or emotional state. Therefore, we plan to extend the VP with a mental model and related reasoning rules to govern the simulated mental states. Our findings from the previous step guide us in the design of the agent (e.g., the cognitive architecture and the dialogue interaction) as well as the educational part (e.g., teaching strategies). We imagine creating mental models with various starting configurations, for example, beliefs, values, and desires an agent might hold at the start of the conversation. Furthermore, the simulated agent should have the ability to reason on how it intend to achieve its desires, or specific conversation goals. Adding this to VP will increase its complexity as this adds a new dimension [10]. An agent, for example, might change its belief from time to time depending on the current state of the conversation, which, in turn, will change what its goal is. In developing such a training system, we have worked in collaboration with the Dutch Child helpline, Kindertelefoon[2]. In previous research [5], a virtual child persona was developed that modeled the child's beliefs and interactions to train counselors at the helpline. However, evaluation with the counselors found no increase in their self-efficacy after interacting with the virtual child. We believe that extending the system with guiding feedback might change this, e.g., help learners interpret the agents thinking and behavior, as well as a counseling strategy that might effectively support the child.

2.3 Generated Reflection

We will look mainly at three types of reflection: (1) guidance, which happens during interaction with the VP, (2) feedback provision, which shows the incorrect choices made by the trainee, and (3) suggestions to improve in future runs. These types of reflection can be generated from the agent's mental model (e.g., their beliefs) or from the dialogue interactions (e.g., not following the correct protocol). Guidance can occur in different forms. For example, a pedagogical agent could guide the learner while interacting with the VP [22]. As for feedback, it is important to avoid cognitively overloading the learner [29]. Feedback, therefore, needs to be specific, actionable, and adjusted to the skills and abilities of the learner at that stage [26] [9]. We intend to empirically study the impact, trust, and acceptance of reflection feedback on learners.

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[1] https://osf.io

[2] https://www.kindertelefoon.nl/

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