Towards a Reflective Practicum of Embodied Conversational Agent Experiences

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Abstract—A reflective practicum is a low-pressure, low-risk learning environment. In a reflective practicum a learner is educated in a professional practice and how to use reflection in the setting of that professional practice. An example of a low-pressure and low-risk learning environment is the use of embodied conversational agents (ECAs) in medicine to provide training for interviewing and diagnostic skills. However, such ECA experiences have not been used to teach how to use reflection in the setting of a professional practice. In this paper we present a framework that supports explicit reflective learning for ECA experiences. Using this framework, ECA experiences become a reflective practicum.

This framework was applied to an ECA experience called the Neurological Examination Rehearsal Virtual Environment (NERVE), and created a sample experience called the NERVE Reflective Practicum (NERVE-RP). We conducted a user study in which second-year medical students (n = 76) used NERVE-RP and engaged in reflection based on the experience. The results of the user study show that students engage in valuable reflections during the experience including instances of critical reflection.

Keywords—reflective learning; reflective practicum; embodied conversational agents; virtual patients

I. INTRODUCTION

Schön [9] defined a “reflective practicum” as a setting designed for the task of learning a professional practice (e.g., medicine). In a reflective practicum students also learn how to use reflective learning in that professional practice. A reflective practicum is meant to be a low-pressure and low-risk environment for the learner. In a reflective practicum, a facilitator supervises learners as they engage in two kinds of experiences: a) simulated experiences that approximate real world scenarios they might face in their professional practice or b) real-world experiences under close supervision from the facilitator. In a reflective practicum, the facilitator challenges the learners to face situations they might not be familiar with and prompts them with questions that help them reflect on previous knowledge to solve the uncertain situations that arise.

An example of such a low-pressure and low-risk environment is the use of embodied conversational agents (ECAs, also known as “virtual humans”) to train learners for interpersonal scenarios. ECAs have been used to provide learning interventions for medical interviews and examinations [4]. These learning interventions share characteristics with the reflective practicum that Schön described: 1) they are a low-pressure and low-risk environment where learners can make mistakes and 2) they are a simulated experience that approximates the real world. In addition to these characteristics, ECAs provide additional benefits that help create important learning experiences. For example, ECAs can provide hands-on exposures to cases that could not be replicated by a human actor. In a medical setting, ECAs can display pathologies that include physical findings such as facial paralysis [4].

While ECA experiences fit the characteristics of a reflective practicum, these experiences have not yet been used to teach how to use reflection in the setting of a professional practice. Reflection can be critical in learning from these ECA experiences. Reflection helps the learner understand the experience and how the lessons learned apply to their professional setting [2]. In this paper, we present a framework that provides an explicit reflective learning component to ECA experiences. This framework allows ECA experiences to fully become a reflective practicum.

This framework was applied to the Neurological Examination Rehearsal Virtual Environment (NERVE) to create the NERVE Reflective Practicum (NERVE-RP). NERVE is an ECA experience in which medical students train by interviewing and examining ECAs suffering from cranial nerve palsies. Cranial nerve palsies present asymmetric eye movement or facial responses and often are an indication of underlying potentially life threatening conditions. We used the presented framework to enhance this training application and prompt medical students to reflect on how this interaction can improve their professional practice. We present a user study in which 76 second-year medical students used NERVE-RP. The results from the study show students engaged in valuable reflections during the interaction, including instances of critical reflection. The results also show a statistically significant negative effect in the reported social presence of the ECA when learners engage in reflection during the interaction, these results highlight the need to balance the value provided by reflections with the potential to lose realism of the simulated experience.

II. RELATED WORK

A. Reflective Learning and Reflective Practicum

As described by Schön [9], a “practicum” is a learning setting where learners are instructed in a professional practice by participating in simulated experiences that approximate the real world under the supervision of a facilitator. This kind of
Reflection can happen at three different moments of a learning experience. Reflections happening before the experience are before-action reflections. Reflections happening during the experience are in-action reflections. Reflections happening after the experience are on-action reflections.

“experiential learning” provided by a practicum is common in health sciences. Boyd and Fales [2] proposed that “reflective learning” is a key element of the process of learning from experience. Reflective learning is “the process of internally examining and exploring an issue of concern, triggered by an experience, which creates and clarifies meaning in terms of self, and which results in a changed conceptual perspective” [2, p. 100]. In other words, reflection is an activity that transforms an experience into learning. When the activity of reflection is incorporated into a practicum and learners are encouraged to use reflection in their professional practice, the practicum becomes a reflective practicum [9].

Reflection in a reflective practicum can happen at three distinct moments of a learning experience: before, during, and after the experience. Figure 1 shows the different moments of reflection. Schön [8] originally differentiated between two of these moments of reflection by calling reflections after the experience “on-action reflections” and reflections during the experience “in-action reflections.” Later, Greenwood [3] would describe the importance of reflections before an experience and described them as “before-action reflections.” In a reflective practicum, learners are encouraged to engage in reflection at all of these moments.

1) Reflective Practicum in Medical Education: In the context of teaching interviewing skills for medical education, two scenarios arise: a) the experience is for a novice student and consists of an interaction with an actor pretending to be a patient (called “standardized patient”) or b) the experience is for an advanced student and constitutes an interaction with an actual patient being supervised by a facilitator. These two scenarios relate to Schön’s description of a reflective practicum.

2) Reflective Learning Assessment: Most of the literature focusing on assessment of reflective learning focuses on assessment of on-action reflective journals. Assessment of such reflective journals is a challenge: determining what makes a reflection good or valuable can be difficult. Wong et al [10] developed a coding schema for levels of reflection present in reflective journals. They identified three levels of reflection: non-reflection, reflection, and critical reflection.

3) Computer Supported Reflective Learning: Reflection should not be limited to learning environments such as a reflective practicum. Schön [8] described professionals that use reflection to evolve their professional practice as “reflective practitioners.” Computer Supported Reflective Learning (CSRL) has been proposed as a model to use technology to enhance reflective learning exercises in the workplace [5]. Our work builds on the ideas of CSRL but contrasts with it in that the proposed framework looks to include reflective learning into training experiences involving embodied conversational agents.

B. Embodied Conversational Agents

ECAs have been used to train learners in interpersonal skills for medical interviews and examinations [4]. In these learning interventions ECAs provide valuable opportunities for learning from experience. In these experiences, ECAs have been used as virtual patients. Learners can interact with virtual patients to develop and practice their interviewing and diagnosing skills. Virtual patients serve a similar role to that of standardized patients and can be used in cases which standardized patient encounters are not possible. For example, virtual patients can display pathologies with physical findings that standardized patients cannot, such as cranial nerve palsies [4].

ECAs provide valuable experiences to learners and help them develop skills required for their professional practice. However, reflective learning has not been explicitly incorporated into these experiences. The presented work describes a framework that allows for an explicit reflective learning component to those experiences. This reflective learning component includes reflection in all three moments of the experience: before-action, in-action and on-action. Such a framework did not exist in the past, and virtual human experiences did not explicitly prompt learners to reflect in the different moments of each learning experience. The framework presented allows virtual human experiences to become a reflective practicum for learners to develop their professional practice.

III. FRAMEWORK FOR A REFLECTIVE PRACTICUM WITH VIRTUAL HUMANS

We have designed a framework that supports explicit moments of reflection in an ECA experience. This framework allows experiences with ECAs to be a reflective practicum. This framework is general and can be applied to any learning experience involving interaction with ECAs. The framework includes elements that allow reflections at all three moments described by literature in reflective learning. The framework follows the theories of the reflective practicum developed by Donald Schön [8], [9]. The framework is general, however we also present NERVE-RP (refer to Figure 2), a sample experience implementing this framework. NERVE-RP allows medical students to practice their patient interviewing skills by interacting with a virtual patient. This virtual patient presents asymmetric eye movement produced by a cranial nerve III palsy (see Figure 2.a). While describing the framework we reference NERVE-RP to illustrate the concepts being described.

The framework consists of three elements: 1) a virtual facilitator, 2) an abstraction for reflective moments in a virtual human interaction, and 3) a set of guidelines for designing an
Fig. 2. NERVE-RP is an application that implements the presented framework. (a) Shows the ECA students interact with in NERVE-RP. (b) Shows the virtual facilitator used in NERVE-RP. (c) Shows the interface used in NERVE-RP to answer reflective learning prompts.

interface for students to answer the reflective prompts during the interaction.

A. Virtual Facilitator

In a non-virtual learning setting, a human facilitator asks learners questions to guide them in their reflections of the learning experience. In a virtual setting, a human facilitator could also ask the questions to the learners; however, this is not always possible due to the limited availability of expert practitioners that can play the role of the facilitator. Also, having a human facilitator would limit the standardization and replicability of the learning session. In order to address these points, we propose the use of a virtual facilitator.

The virtual facilitator is an ECA that prompts learners with reflective questions. In order to ask the questions to the learners, the virtual facilitator needs to be introduced to the students before the experience starts. A natural moment for this introduction is during the tutorial of the ECA system. Having a tutorial is common practice in ECA experiences (e.g. [4]). During the tutorial, the virtual facilitator can teach students how to interact with an ECA and how to perform different activities in the virtual environment. During the tutorial, the virtual facilitator should demonstrate knowledge of the particular field of expertise, to establish himself as an expert practitioner to the learners. In the case of NERVE-RP, the virtual facilitator taught the medical students how to perform a neurological examination on their virtual patient using different virtual tools that were available. Figure 2.b shows the virtual facilitator in NERVE-RP.

B. Abstraction of Reflective Moments

In a non-virtual learning setting, the facilitator engages in conversations with the learner to trigger meaningful reflections. These conversations can happen before, during or after the learning experience. In these conversations, the facilitator poses questions to the learner. These questions are usually open-ended. The questions allow the learners to reflect on: 1) what skills they need to work on, 2) similar situations they have faced that might be relevant to the present activity or 3) how the present activity can affect their approach to real activities in the future. For example, in a learning setting with a patient with a cranial nerve palsy, a facilitator might ask the learner: “what similar patients have you examined before in your professional practice? What skills helped you reach a correct diagnosis for those patients?”

We propose that these reflective conversations can be modeled in an ECA experience by a series of questions that the virtual facilitator asks to the student at particular times of the experience. Examples of these times can be: 1) at the beginning of the interaction to set the learner’s objectives 2) when the learner performs a particular action in the interaction (e.g. when the learner starts the physical examination of a patient), 3) after a set amount of time of the interaction has passed and 4) at the ending of the interaction to perform a debriefing of the experience. The particular times and the questions to be asked should be decided by the educator.

In the case of NERVE-RP, four different sets of questions were added to the interaction. 1) At the beginning of the interaction, the facilitator asked the learners to set goals and make a plan for their interview of the patient. 2) When the learner started the physical examination of the patient, the facilitator asked the learner which physical examinations were relevant to the condition of their patient. 3) After four minutes of interviewing, the patient would express concern about her condition. At this time, the facilitator asked the learners to consider how they would feel if they were in their patient’s position and to reflect on how to handle her concerns. 4) At the end of the interview, the facilitator asked the learners to analyze their performance and how it can be used in their professional practice.

C. Guidelines for the User Interface

The system needs to provide the learner with an interface to answer the reflective questions when they are triggered. Figure 2.c shows the interface we designed as part of NERVE-RP. We propose the following guidelines for designing such an interface:

- Conveying to the learner that the virtual facilitator, as a surrogate for the expert practitioner, is asking the questions. In the case of the interface implemented for NERVE-RP, a frame containing a static image of the virtual facilitator was included in the top left corner of the interface.
- Conveying that the other ECAs in the learning experience
are unaware of the reflective conversation with the virtual facilitator or have agreed to wait while the learner engages in reflection. In NERVE-RP, when the interface was presented to the learner, the interaction was paused. To show this pause, the virtual patient’s behaviors (such as gaze and animations) were paused, and the virtual clock in the wall was also stopped. The scene was also dimmed to prevent distractions and keep focus on the in-action reflection.

IV. USER STUDY

The primary goals of the user study were to evaluate NERVE-RP’s effectiveness in eliciting meaningful reflections and to compare NERVE-RP’s performance as related to a traditional approach without reflective learning questions. The study used a between-subjects design with two conditions: treatment and control. 1) Participants in the treatment group went through the experience and received reflective prompts form the virtual facilitator. The prompts included questions at all three moments of reflection. 2) Participants in the control group went through the experience without any reflective prompts, but did engage in on-action reflection after the user evaluation was concluded. The on-action component for the control condition was included to guarantee a similar learning experience for all learners.

A. Participants

The participants were second-year medical students at the University of Central Florida Medical School. Participants were required to interview the virtual patient, but they were allowed to opt out of the research component of the exercise. Participants were not graded and did not receive compensation for their participation in the user study. A total of 76 students consented to participate of the user evaluation (38 female). Participants were evenly distributed among the two conditions (38 treatment, 38 control). All the participants had prior knowledge on the evaluation of neurological conditions similar to the one presented by the virtual patient in NERVE-RP.

B. Procedure

Each participant went through the experience individually using laptop computers issued by the University of Central Florida Medical School. For both conditions the experience was an hour long. The experience included: 1) a pre-experience survey, 2) a tutorial guided by a virtual facilitator, 3) interview and examination of the virtual patient, 4) virtual patient assessment, and 6) a post-experience survey. In the case of the control group, a set of on-action reflective questions was included after the post-experience survey to guarantee a similar learning experience.

C. Metrics

1) Reflective Responses: Answers to the reflective prompts provided by the participants were recorded. The answers were later coded by three raters as either: 1) having no evidence of reflection, 2) having evidence of reflection or 3) having evidence of critical reflection. This coding followed the definitions provided by Mezirow [6] and Plack [7].

2) Social Presence: One concern about the pauses for in-action reflective moments was that the pauses could negatively affect the perception of social presence of the virtual patient. Social presence of an ECA is defined as the feeling that another person is in the room with you [1]. Social presence was measured using the questionnaire developed by Bailenson et al. [1]. The five survey items were asked on a seven-point Likert scale from “strongly disagree” to “strongly agree”.

D. Hypotheses

Primary Hypothesis: reflective responses from the students will demonstrate evidence of all three levels of reflection.
Secondary Hypothesis: the reported social presence of the virtual patient will not be significantly affected by the use of in-action reflective learning prompts during the interaction.

V. RESULTS

A. Reflective responses ratings

The reflections recorded from the students were rated by three raters. The three raters were researchers with experience in virtual patient experiences. The raters were instructed on the rating scale developed by Mezirow and trained for three sessions with reflective learning data sets of medical professions students interacting with a different virtual patient. After training, all three raters individually rated all the reflections for the presented case. For each reflective learning moment the average value between all three raters was taken as the level of reflection for that user in that moment.

Interrater reliability for the ratings was determined using an intraclass correlation coefficient (ICC). The ratings of the treatment condition achieved a reliability of ICC(3,3) = 0.745(p < 0.001). At least two raters agreed on the rating value for each reflection for 99.14% of the cases and all three raters agreed on the rating for 56.03% of the cases.

According to the ratings, 22 out of 38 students (57.9%) demonstrated evidence of reflection in at least one of the reflective moments. All three raters agreed that only one student in that group demonstrated evidence of critical reflection in at least one of their reflective responses. The answer provided by the student was:

Reflective question: “How do you plan to address Ms. Larson’s concerns?”

Student 14: “I can only reassure her that we are doing everything we can. As this is a virtual patient it is difficult to feel empathy for a video game, but in real life I probably would have a more empathetic response. I would likely let her know that I need to figure out how things are going, (...) and that it is too early to tell if I can fix anything.”

B. Social Presence

Two items of the social presence scale were reverse coded as they represent negative statements. Overall the virtual patient received average ratings ranging from ‘neutral’ to ‘low’ for all self-report social presence survey items. The survey had good reliability (Cronbach’s α = 0.84). We performed independent
sample t-test between groups for each item. Only the item “I perceived that I was in the presence of a patient in the room with me” resulted to have a significant difference ($p = 0.047$) between the control condition ($M = 4.00, SD= 1.53$) and the treatment condition ($M = 3.24, SD= 1.76$).

VI. DISCUSSION

A. Reflective responses ratings

We accept our primary hypothesis. NERVE-RP was able to elicit responses with evidence of reflection from 57.9% of the students. This percentage is low compared to other literature such as the one presented by Plack et al. [7] which observed reflection in 85.3% of the students. However, the assessment of reflections in the study by Plack et al. was performed with reflective journals in which the students made multiple entries over several weeks without time constraints. In our study, the students spent only one hour interacting with the virtual patient and generating the responses to the reflective prompts. The time limitation caused shorter answers and fewer opportunities for the students to demonstrate their own reflective process. A better comparison could be achieved by comparing the reflective answers generated by our treatment group and comparing them to the answers generated by the control group after the experience was over, due to the fact that students in the control condition also engaged in a single interaction with a time limit. Initial findings from this comparison show a higher percentage of students reflecting in the treatment group. However, such a comparison falls outside the scope of this paper.

B. Social Presence

We have to reject our secondary hypothesis. The reflective learning component of NERVE-RP introduces breaks in social presence that need to be accounted for. Our results show that these breaks can negatively affect the reported social presence of ECAs in the simulation. Such effects can have repercussions in the perceived realism of the ECA. This finding highlights that instructors need to be careful when including in-action reflective learning prompts to a simulation. The guideline we propose is that the in-action reflective prompts need to bring enough value to the learner to account for potential losses in the realism of the interaction.

The overall neutral to low social presence scores given were expected because: 1) the interaction was performed in a low immersion setting (i.e. a web page in a laptop computer) and 2) the interaction was typed, using no speech-recognition. Given that NERVE-RP presented relatively low social presence, we speculate that the negative effect produced by the in-action reflections could become even larger if our framework is used in a simulation that presents higher social presence. However, further research is required to understand such effects.

VII. CONCLUSION AND FUTURE WORK

We have presented a general framework that allows an ECA experience to become a reflective practicum. This framework allows ECA experiences to introduce reflective learning prompts before, during and after the interaction with the ECA. These reflective prompts can help students better understand their interaction with an ECA and how the experience applies to their professional practice.

We have also presented NERVE-RP, a sample experience that implements this framework in the setting of an interview with a virtual patient. Using NERVE-RP, we conducted a user study with 76 second-year medical students from the University of Central Florida Medical School. The results of the study show evidence of both reflection and critical reflection from the students. Additionally, the study showed that introducing reflective learning during the interaction can have a negative effect on the reported social presence for the ECA. This result highlights the importance of balancing the possible loss of realism and the educational benefits provided by allowing the learners to reflect during the interaction.

In the future we plan to include dynamic in-action reflective moments to NERVE-RP. In its current implementation, NERVE-RP only supports reflective moments that contain a static set of prompts that are asked sequentially to the learner. However, reflection in-action is usually a conversation between a facilitator and a learner. To completely model this behavior, there is a need to determine the basic ideas expressed in the reflective answer as provided by the learner, to make decisions about what the next reflective prompt should be.

ACKNOWLEDGMENTS

Research reported in this paper was supported by the National Institutes of Health (NIH) under award number 1R01LM010813-01. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health.

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