Simulated RN | Virtual Healthcare Agent

M3 | William Morse

Summary

The Simulated RN is a virtual healthcare agent designed to provide interactive patient education at the time of discharge in the post-partum unit of the hospital. The discharge process can have an impact on numerous factors associated with patient care and hospital-related outcomes. The discharge process influences many aspects of healthcare, including patient understanding of their care, patient satisfaction, the potential for adverse outcomes, hospital efficiency connected to bed availability as well as the overall quality of hospital services. The most common factor influencing the frequency of adverse events in healthcare relate to poor communication between hospital caregivers and the patient during the delivery of discharge instructions (Forster, Murff, Peterson, Gandhi & Bates, 2003).

The Simulated RN project will utilize a virtual healthcare agent that is designed to deliver face-to-face consultation with patients while upholding a natural appeal. The main design goal is to improve the discharge process by providing an interactive learning environment that enriches user tasks through communicative commonality. It is predicted that reducing barriers in communication during the discharge instruction process will subsequently improve the acquisition of knowledge, patient comprehension and satisfaction. The Simulated RN can increase the availability (accessibility) of time spent with patients while providing a prescribed way of discussing and presenting learning material to achieve consistent user experiences. Furthermore, the virtual healthcare agent is supported with a range of media elements such as text, images, and video to expand and provide patients with materials that support their learning preferences. Evidence has shown that the use of visual aids and other media increases a patient comprehension of their medical instructions (Austin, Matlock, Dunn, Kesler, & Brown, 1995; Johnson,

Sandford, & Tyndall, 2003). The Simulated RN interface can be mounted to a wall or a mobile cart with an articulate arm, so that it can be unobtrusive to the hospital environment when not in use.

Requirements

The systematic analysis of cross-functional requirements includes both short and long term targets. All interface requirements focus around the concept of expanding the communicative commonality (e.g., reducing barriers to communication) between the system and patient. To perform the tasks successfully, an individual must be enabled with functionality to perform each task satisfactorily. The requirements listed below are representative of the abilities that the system must support, including accommodations to enable individuals with disabilities to perform the essential functions.

Short Term Functional Requirements

In the short term, the preliminary interface shall autonomously—in parallel with hospital staff—facilitate the intended workflow of the teaching and instruction component of the discharge process. This requirement will increase educational time spent with the patient, while reducing time constraints on healthcare providers.

The interface shall communicate through natural speech. The system shall include simplified navigation that allows the users to interact without needing to ask for help. The system shall support tasks completed through touch-based user inputs. These requirements will improve hospital efficiency by improving communication, better patient understanding, while reducing processing time and rework.

The interface shall support an instructional framework that is modeled after the accepted post-partum teaching and instruction experience. The prototype system shall accommodate the multisensory modalities of users through use of audio, visual and kinesthetic touch. These multisensory functions shall accommodate various user learning styles (Johnson, Sandford, & Tyndall, 2003), including subject matter content supported by visual aids (Koonce, Giuse, & Storrow, 2011). These requirements will improve the acquisition of knowledge, patient comprehension and satisfaction.

Due to the concerns with literacy levels for some patients, and addressing the needs of the hearing-impaired, the interface shall combine audio/verbal narration with written subtitles to further enable user participation (Johnson, Sandford, & Tyndall, 2003). The dialogue content and readability, including visual illustrations must support the user's ability to understand the content (Austin, Matlock, Dunn, Kesler, & Brown, 1995). Therefore, the interface shall also support multiple languages to further assist patients with various language needs (e.g., Spanish, Arabic). These requirements will further improve communication and accessibility.

Behavioral Requirements

The system shall provide virtual face-to-face consultation with patients in a manner that 'feels' instinctively natural (e.g., shall include high behavioral realism). The system shall elicit social reactions from the user through virtual social cues (e.g., conversation, nonverbal gestures).

Environmental Requirement

The interface hardware shall keep a low profile in the patient room in an unobtrusive manner.

Long Term Functional Requirements

Empirical investigation will be needed in the future to demonstrate the effectiveness of these proposed requirements in the preliminary design. In the long term, the interface shall provide information that supports cognitive learning and evaluation of user comprehension. Due to the various literacy levels of users, the system will assess and adjust its instructional framework to complement the user's comprehension framework (e.g. reading level, utilization of visual elements such as video and animation). The system shall influence healthcare outcomes by lowering adverse events through effective instructional content. The system shall increase patient satisfaction with the interface allowing users to achieve a better understanding of their healthcare.

Design Space

The design space for the Simulated RN is a complex environment with many causal relationships between factors (e.g., functional, behavioral, perceptual), each essential to the overall design. The design space included (3) primary tradeoffs related to major issues of the design: the visual character, the audio character and interface navigation. These major issues mainly focused on natural appeal (high agency and high behavioral realism), communication and presentation of information rather than underlying technological concerns.

A central requirement to the conceptual design requires that the interface shall simulate face-to-face consultation with patients while upholding a natural visual and auditory appeal. The affordance of this instinctive approach is expected to increase usability through communicative commonality that is familiar to the patient. According to the Ethopoeia concept, if the design space includes social cues, such as interactivity, natural speech, or the filling of social roles, natural feelings are triggered and intrinsic social behaviors are performed (Putten, Kramer, Gratch, & Kang, 2010). The transfer of this nonverbal outward appearance (e.g., affect, user perception) into the interface can be a potential barrier. Therefore, the design space must elicit strong social reactions through high agency and behavioral realism.

The first option of significance had to do with using a virtual healthcare agent (animated character) versus a real human agent (video recorded person). For the purpose of analysis, each tradeoff was classified into the criteria of advantages and disadvantages.

Visual Character in the Design Space

Video Recorded Character (Human)

Advantages: It's rather simple to point a video camera at a person and record them, capture and edit the video. The equipment and software are relatively easy to obtain and learn.

Disadvantages: People (actors) change overtime, or simply move onward. If an edit is required in the video content later on, an ensuing need follows that requires developers to find the original actor and hope they haven't changed (e.g., hair style, age, skin tone). Using a different person for a segment disrupts continuity. The alternative is to re-record the entire section of the video segment, which is time intensive to repeat and this option does not address the potential of the problem reoccurring.

Finally, in order to support a natural appeal (e.g., high behavioral realism) regarding the transition of the visual character, in relationship to user interaction, the transitions must be seamless. The interactive sequences of action require every segment to match the start and end positions of the character pose. Without the alignment of start or end of the character poses, user interactions will result in a visual jump or unnatural bodily movement in the position of the character. Video recorded human actors are very difficult to align with perfect starting and end positions, which can result in abnormal movements and potentially negative user perceptions (MacPherson, 2009; Brown, 2011).

Animated Character (Virtual Agent)

Advantages: The main advantage of using animation is the control over every aspects of the character, including appearance, position, and pose. An animated character does not age and can look the same over several years, if necessary. The computer generated scenes consist as files that store exact details which can be edited afterwards. The *Threshold Model of Social Influence* suggests that a user will intuitively respond socially to another human or in a virtual reality environment to a high agency character (Putten, Kramer, Gratch, & Kang, 2010; Blascovich, 2002; Blascovich et al., 2002). As a result, the quality of the animated character must have high agency resembling human features.

Disadvantages: The use of computer generated people can result in an affect referred to as the *Uncanny Valley*. The theory holds that when human likeness are used in characters that resemble and act like humans, but not perfectly, it may cause a negative emotional response in the observer (MacPherson, 2009; Brown, 2011). This theory holds true for video recorded human movements as well, as outlined earlier. Furthermore, animators must consider nonverbal communication and body gesture cues that may not always be overtly perceptible.

In comparison of an animated character in the design space with the video recorded character, the animated character was preferred mainly because of the enduring advantages. The use of 3D animation in the design structure provides for more control and the ability to edit. In addition, research has revealed that when a user knows that a virtual character is a representation of a human being, and the agency high, social instincts take place allowing for social effects to occur (Putten, Kramer, Gratch, & Kang, 2010). The use of a high agency character should reduce the potential of a negative affect during user interactions.

Audio Character in the Design Space

Another major issue related to the use of human speech versus computer-generated speech. Face-to-face consultation remains one of the most instinctive methods of communicating and most often requires auditory speech (Qualls, Harris, & Rogers, 2002). Many of the same arguments that were previously outlined for the visual character can also be made for the audio character. It's important to provide speech that a user can clearly understand, which may affect the user's ability to receive information (e.g., ability to follow instructions, navigation, and comprehend material). Computerized speech can be difficult to support because the generated speech may not always pronounce words correctly and the synthetic speech articulation is often noticeable by users. Many speech engines provide limited options to directly correct the phonetic speech, or in some cases, the process requires an advanced understanding of the technology.

In regards to user perception, the principles of the Uncanny Valley effect would suggest the use of a computer-generated speech might actually aid in the user acceptance of a computer-generated visual character, since the visual and audio elements clearly correspond as being computerized. Results from previous research indicate that if a user's expectation agrees with the simulated experience the user is less likely to generate a negative response (MacPherson, 2009; Brown, 2011). Therefore, the preference to use computer-generated speech is predicted more favorable in this design space.

Interface Navigation in the Design Space

The preference for computer hardware or a specific platform in the design space can affect the environmental space as well as the navigation structure. It is more customary for users to use a mouse and keyboard to interact with computer hardware, but in a patient room, these devices would require additional environmental space for storage and use. Touch-based technology is part of a growing trend in modern interface design. The touch-based technology is popular in mobile and tablet interfaces, which may provide some users with a degree of familiarity, but may not be intuitive to all users.

As part of the environmental requirement of the hospital, the computer platform had to keep a low profile in the patient room. In conclusion, the Dell Inspiron 2320 all-in-one touch screen computer was selected as the target device for this design. This computer was chosen because it offered a thin structure that could be wall, or cart mounted, so that in the hospital environment it would not occupy much space and could be deployed as needed. In addition, the Dell Inspiron 2320 includes a large display surface consisting of a 23-inch touch screen at a relatively low cost.

Finally, it is believed that voice recognition navigation—utilizing the computer microphone—is the most natural method to communicate user input and is an inevitable future design space target, but is not supported in this prototype design. It is recognized that the patient room could be a noisy environment, which might make developing such user inputs difficult to support.

The Design

The main design goal was to improve the discharge process by providing an interactive learning environment that enriches user tasks through enhanced communication. Information is conveyed in many ways including symbols, images, language, sound, gesture, touch, eye contact, and text. The Simulated RN is designed to embrace a variety of natural communication methods to expand the area of communicative commonality with patients. The presentation of information in the interface utilizes a stereotyping approach to user modeling, where the virtual healthcare agent represents an expert instructor or nurse. The virtual agent models the behavior and information exchange commonly experienced during the discharge teaching and instruction process. The purpose of this approach is to elicit natural social reactions through high agency and behavioral realism. In addition, the appearance and communication are designed to provide the user with an awareness of their role in each situation while using the interface.

Context of Use

In the hospital environment the initial workflow and interactivity with the system is commenced shortly after delivery (post-partum), during recovery, but before leaving the hospital. The Simulated RN interface can be mounted to a wall or a mobile cart with an articulate arm, so that it can be unobtrusive to the environment when not in use. The articulate arm allows the interface to be positioned to support a patient sitting or lying down in a conventional hospital bed. The preliminary interface shall autonomously—in parallel with hospital staff—facilitate the intended workflow of the teaching and instruction component of the discharge process. The patient's interactions with the system are asynchronous allowing the user some control over the rate of progress. The content structure was adopted utilizing recommendations provided in the *Discharge Procedures for Healthy Newborns* (Langan, 2006).

Design Workflow

A scenario-based approach to interface design was adopted to provide a structure of organization to the primitive concept. A flowchart was constructed, similar to a storyboard, to illustrate the "big-picture" view and intended workflow depicting a proposed set of task scenarios (see Appendix A). This approach provided a view of task sequences that allowed for the identification of measureable moments related to user performance. Therefore, the task sequences were designed to correspond with the usability measurement criteria based on Nielsen's *Usability Engineering* (1993): time to learn how to operate the system, speed of user performance, and the rate of errors made by users and the user's satisfaction with the system (see M2: Measures; more details will be provided in M5).

<u>Task Scenarios Table</u>

<table>
<tr><th></th><th>Task Description</th><th>Related Requirements</th><th>Usability Performance Metrics</th></tr>
<tr><td><u>Task 1</u></td><td>The user will be given instructions by the virtual healthcare agent outlining the intended workflow, including how to provide user input and navigation. The first task is to determine whether the user understands the basic instructions by answering the question—Are you ready to begin?</td><td>Communication, intended workflow, natural speech, simplified navigation, touch-based user inputs</td><td rowspan="2">Count frequency related to failure to make a selection.

Count frequency related to the accuracy of a selection (e.g., correct or incorrect intention of selection).

Time required</td></tr>
<tr><td><u>Task 2</u></td><td>Educational content will load and the virtual healthcare agent will provide additional instructions and teaching material. The Simulated RN shall monitor user preferences. The system can provide</td><td>Instructional framework</td></tr>
</table>

	information related to user interest making the subsequent experience patient-centric. The second task is designed to determine a user's preference for feeding the infant (e.g., breastfeeding, formula feeding). The user's selection will be stored and subsequent educational content will correspond to this selection. For example, bowel movements correlate with feeding preferences. If a user selects formula feeding, the bowel movement section will emphasize information related to the previous selection (patient-centric).		selecting (in seconds). All of the tasks require touch-based user input or responses.
<u>Task 3</u>	The virtual healthcare agent will provide additional instructions, education and multimedia content. The third task is another user preference. The Simulated RN will ask the question, "Would you like to an education video related to feeding baby?" The user will select either yes or no. The interface shall provide educational content to accommodate user learning styles, visual aids and preference.	Instructional framework, multisensory, accommodate various user learning styles, visual aids	

Virtual Agents

There is a significant body of research on the use of virtual characters in interface design. Designing systems that appear to resemble human beings (Anthropomorphic design) or human behaviors may provide a psychological advantage in interface design. Corresponding to the *Threshold Model of Social Influence* human beings initially only respond socially to other human beings (Blascovich, 2002; Blascovich et al., 2002). This supports the notion that virtual human characters of high agency represent an existing intrinsic mental model for social interaction. Therefore, once the temporal novelty of the situation vanishes, the user becomes accustomed to the interaction with the interface (Blascovich, 2002; Blascovich et al., 2002; Kiesler & Sproull, 1997). According to Putten et al., (2010) "When the factor agency is high, (e.g., when the user knows that the virtual character is a representation of a human being), then the factor behavioral realism does not have to be high in order for social verification to take place and for social effects to occur" (p. 1642). Furthermore, Putten et al, (2010), concluded on the basis of the empirical findings that agents and avatars with higher behavioral realism provide more social cues and therefore elicit more social response.

The definition of virtual characters provided from Putten et al, (2010):

- An agent is defined as an acting entity, which in includes artificial intelligence that renders the control by a human dispensable.
- An avatar, by contrast, is a virtual representation of a human being, which is controlled completely by the human.
- An embodied conversational agent does not require control by a human; it decides which sentence it is going to say next on the basis of its artificial intelligence (p. 1641).

Proof of Concept

The use of virtual agents in healthcare is not new, over the past several years the Boston Medical Center in collaboration with Northeastern University have yielded promising results using an embodied conversational agent named *Louise* (Project RED). The Simulated RN design has been notably influenced by, and modeled after, many of the aspects in the Project RED design. For example, both interfaces use the natural format of face-to-face conversation model of interaction. The Simulated RN will accomplish this in a similar manner to the Project RED method using an animated character that talks to patients using computer-generated speech and synchronized body language behavior, such as hand gestures. In both designs, the patients communicate with the virtual agent though touch screen input responses (Bickmore, Gruber, & Picard, 2005; Bickmore, Pfeifer & Byron, 2010).

Usability evidence presented from the Project RED research suggests that patients with different levels of health literacy find the virtual agent acceptable and easy to use for automated health communication (Bickmore, Pfeifer & Byron, 2010). According to Bickmore & Jack (2009), “In a pilot study of the automated ‘virtual nurse’ system, 74% of hospital patients said they preferred receiving their discharge instructions from the virtual nurse, rather than their human doctors or nurses” (p. 7). In 2008, a randomized controlled trial comparing the affect of the Project RED process with usual care resulted in a 30 percent lower readmissions rate for patients that used the interface (Bickmore & Jack (2009). These findings suggest that the Simulated RN concept is an externally valid design approach in healthcare.

Nurse Character Design

The Simulated RN's nurse character design will be generated from a 3D character model. The demographic characteristics of the virtual agent are designed to represent a 25-30 year old female, with brown hair and brown eyes. These features along with the agent's skin, which is endowed with slightly darker than normal Caucasian tones, are designed to provide a blended racial appearance. As a result, the agent's virtual racial or ethnic background is determined by the user's perception, which could be Asian, African-America, Caucasian, Hispanic, Middle Eastern, or Native American. Previous research has shown that people apply ethnic stereotyping to virtual agents (Rossen, et al, 2008). Therefore, to reduce the potential of this affect, the agent is designed to be ethnically ubiquitous. Research conducted by Nass, Steuer, and Tauber (1994) observed a gender stereotype with virtual characters that related to the type of information being presented. Based on the primary user gender and subject matter, a female was selected to represent the nurse role.

The Simulated RN's computer generated speech is lip synchronized to the audio dialogue. The body language will consist of choreographed head turns, hand gestures, random shifts in posture or stance and eye movement with blinking. The overall presence of the virtual agent is designed to promote nonverbal communication, high agency through high behavioral realism, which has been shown to elicit natural social reactions (Blascovich, 2002; Blascovich et al., 2002). To further stimulate the nonverbal communication between the agent and user, the virtual agent is dressed in a modern nurse uniform to distinguish its role.

Interface Layout Design and Apparatus

The user interface for this process can be delivered as a service on a multitude of different HTML 5 compatible devices such as an iPad or laptop, but for this study, the Dell Inspiron 2320 was chosen as the primary apparatus or target device.

The interface layout was designed to match the display settings of the Dell Inspiron 2320. The Dell Inspiron 2320, all-in-one computer includes a large surface area consisting of a 23-inch touch screen.

Screen Size: 23-inch screen with 1920 x 1080 (Full HD) resolution with standard multi-touch.
Colors: The color scheme is designed to complement the nurse's uniform, but in multiple shades.
Font Family: Arial, Helvetica, sans-serif
Text size: Headers (font-size: 24px), Body (font-size: 14px)

Dialogue Design

The dialogues consist of pre-defined information spoken using computerized speech. The natural language mechanism bestows the virtual character with verbal abilities, thereby providing a prescribed way of discussing and presenting learning material to achieve consistent user experiences (e.g., standard messages, reduce variation between human delivery). The system is designed to accommodate multiple languages expanding the literacy range, including the use of nonmedical language. Subtitles are included to support the hearing-impaired users, increasing the approachability or accessibility of the system.

The virtual healthcare agent is designed to be the initiator of the conversation in the interface. The system is designed to support (3) main user tasks (see *Task Scenario Table*), by communicating the intended workflow and allowing users to provide input. The workflow is directed by the virtual healthcare agent to keep the user on task and the user's input responses are verbally acknowledged by the system. An example of this would be if a mother chose to breastfeed her infant, this selection affects subsequent topic areas such as bowel movements. The output information related to bowel movements has a direct correlation with the previous user input. As a result, the bowel movement section will verbally emphasize information that is centric to the previous patient choice.

In the prototype, the user will simply respond to requests for information from the system. According to Dix et al., (2004) this type of dialog is called *system pre-emptive*. A modal dialogue box will appear prompting the user for input. The use of a modal box provides visual communication to the user that a response is requested.

Voice recognition user input and navigation are inevitable future design targets, but currently exists outside of the scope of this project.

Media Design

The Simulated RN is designed for patients and will consist of a 3D human-like animated nurse character designed to perform virtual human like motions and gestures, while providing audio narration with the ability to support multiple languages. Furthermore, the interface design is supported with a range of media elements such as text, images, and video in order to expand and provide patients with materials that support their learning preferences and ability to acquire knowledge. Evidence has shown that the use of visual aids and other media increases a patient comprehension of their medical instructions (Austin, Matlock, Dunn, Kesler, Brown, 1995; Johnson, Sandford, Tyndall, 2003).

Instructional Design

The Simulated RN is designed to represent an expert instructor nurse that guides patients (as students) through a teaching and instruction process that is model after genuine experiences. The Simulated RN is designed to provide an instructional experience that improves the acquisition of knowledge and comprehension through efficient usability and natural appeal. The scope of the design emphasizes preventive medicine through improved patient education during the discharge teaching and instruction process. The intervention is designed to assist in the transition of healthcare and patient understanding as they prepare to leave the hospital.

Educational research in school settings had shown that virtual characters in an interactive learning environment can have a positive effect on the students' view of the learning experience (Lester, et al, 1986). In addition, the research conducted through Project RED validates that patient education can reduced readmission rates in hospitalized patients, including patients with low literacy skills.

The pedagogy instructional strategy to learning in the Simulated RN is predominately influenced by the constructivist approach. Constructivism considers knowledge to be constructed from experiences in which people engage, such as meaningful tasks, or authentic context important to the art and science of teaching (Vygotsky, 1978). To be effective in the design, and valued by the user, the process must be easy to learn and must accommodate the user's ability to acquire knowledge, in a satisfying manner.

Future Technologies & Social Implications

Future Technologies

Engineered Care (http://www.engineeredcare.com), a team that is involved with the implementation of Project RED virtual agents in healthcare, is currently working on a new virtual agent that utilizes the Unity gaming engine (http://unity3d.com). In April 2012, Chris Corio, the CEO of Engineered Care and I met to discuss the Simulated RN project and current projects in their pipeline.

Working with the health departments in several states, the Engineered Care team is involved with developing a next generation virtual agent (Virtual Health Educator) designed to assist women better understand the federally funded Women, Infants and Children (WIC) program. The use of the Unity game engine allows for quick and easy development across multiple platforms or consoles. The feature rich development tool provides functionality to support interactive 3D content.

Key Features of the Virtual Health Educator

- 2-way communications between Virtual Health Coach and User
- Session transcript viewable by clinical staff
- Closed-captioning and headphone plug-ins
- Simple and thorough health information conveyed with teach-back
- Customized script to meet culture and education needs

IT features of the Virtual Health Educator

- Browser based configuration and management
- Use touch-screen kiosks or download our Virtual Health Coach on your tablet
- Manage the Virtual Health Coach's voice speed
- Turn on or turn off Empathy during a patient session

The use of virtual agents in healthcare is expanding, including the use of virtual patients which function to train novice healthcare providers' differential diagnostic skills (Kenny et al., 2007). Emerging technology could someday provide virtual healthcare assistants in the home that could function to help users with disabilities, by promoting home wellness routines (physical therapy or exercise routines) or reminding patients to take their medicine. Technologies such as voice recognition (e.g., Dragon software, or Apple's Siri), or gesture recognition (e.g., Microsoft's Kinect) provide for a wide range of possibilities in the development of future virtual healthcare agents and patient enhancement.

Social Implications

The Simulated RN project has the potential to directly influence society, especially the lives of infants. A few examples of how low health literacy affects mothers of newborns include, more smoking around infants, increased likelihood of SIDS, mothers less likely to know how to use or read a thermometer, ability to recognize symptoms of infant illness, less likely to follow-up with appointments and less occurrence of breastfeeding (Weiss, 2003).

The social implications of the Simulated RN are mostly related to health outcomes. The Simulated RN is designed to improve the discharge process by providing an interactive learning environment that enriches user tasks through enhanced communication. Key social demographics that increase the potential of limited literacy include low income, unemployed, did not finish high school, minority ethnic groups, and recent immigration to United States and do not speak English, or English is a second language (Weiss, 2003). The social implication of low literacy skills has had an impact related to adverse events, increase in healthcare costs. If the interface can provide information that supports cognitive learning and user comprehension, it could someday influence healthcare outcomes by lowering adverse events.

Potential Negative Social Implications

The use of a virtual agent may have a potential negative social implication related to depersonalizing the post-partum hospital experience. Reduced human interaction between the maternity experts and the patient may affect the support and social relationship. Furthermore, if the design fails to provide a level of high agency, it is possible that the system is perceived as hardware (e.g., tool) rather than a social mechanism to promote health. If the Simulated RN's interface cannot effectively mediate between the user's needs and the system's capabilities, it could result in a negative characterization of the entire process. Therefore, the design must accommodate the user's activity by customizing the system's framework according to their current needs.

In addition, the precise mechanism that will play an important role in automating the recognition of user needs relate to pattern recognition, psychometric analysis (e.g., literacy skills, psychological profile) could lead to expanded design implications. Theoretically, it's possible through interaction with the system to predict a user's potential for post-partum depression. Approximately, 13% of women experience post-partum depression. Early human recognition of the mood disorder is difficult, but meta-analysis research has found significant predictors (Beck, 2001). Therefore, it is possible that the system monitors for various predictors. As a result, some user may reject the notion of using a system that becomes overly observant.

Ethical Considerations

The ethical considerations for information systems mainly include accessibility, privacy, and accountability. The ethical framework of the design is built around the Utilitarian moral that the proper course of design is the one that results in the greatest happiness principle or best outcomes (e.g., happiness, reduce adverse events, improve patient satisfaction) (Melden, 1967). According to John Stuart Mill, "There is not time, previous to action, for calculating and weighing the effects of any line of conduct on the general happiness" (Melden, p.406, 1967). Therefore, the utility of the system design cannot be determined without outcomes (e.g., evidence-based outcomes). Empirical investigation will be needed in the future to demonstrate the social implications of the design.

The Simulated RN is specifically designed to break through communication barriers to increase accessibility. The system will someday use a profile management system related to user interactions to evaluate comprehension, but it will be designed to provide patient privacy, compliant with HIPPA regulations and no personal information about individuals is stored after the session. The accountability of the system will be conducted through continuous evaluation of its effectiveness on healthcare outcomes.

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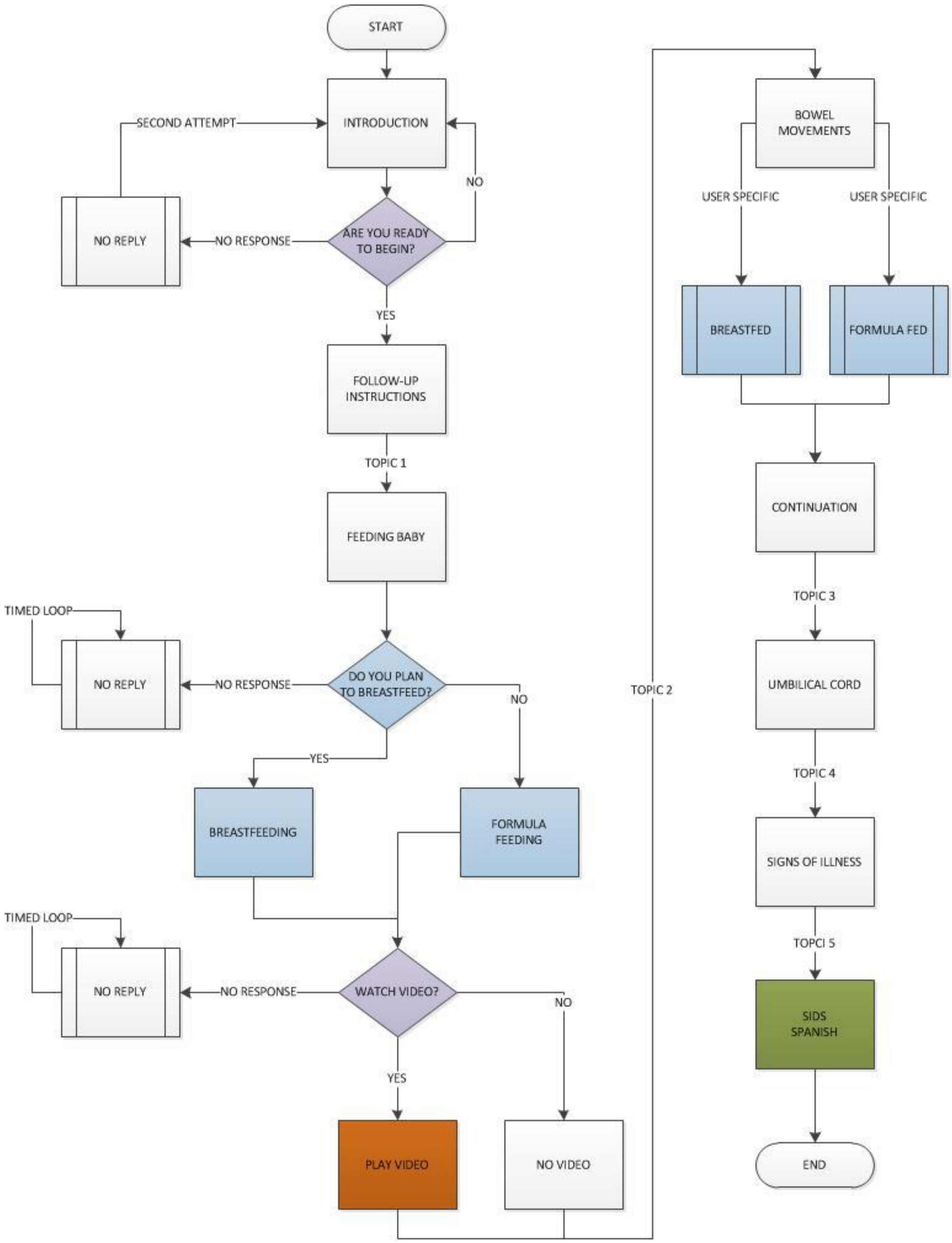
Appendix A



START
INTRODUCTION
SECOND ATTEMPT
NO
NO REPLY
NO RESPONSE
ARE YOU READY TO BEGIN?
YES
FOLLOW-UP INSTRUCTIONS
TOPIC 1
FEEDING BABY
TIMED LOOP
NO REPLY
NO RESPONSE
DO YOU PLAN TO BREASTFEED?
NO
YES
BREASTFEEDING
FORMULA FEEDING
TIMED LOOP
NO REPLY
NO RESPONSE
WATCH VIDEO?
NO
YES
PLAY VIDEO
NO VIDEO
TOPIC 2
BOWEL MOVEMENTS
USER SPECIFIC
USER SPECIFIC
BREASTFED
FORMULA FED
CONTINUATION
TOPIC 3
UMBILICAL CORD
TOPIC 4
SIGNS OF ILLNESS
TOPCI 5
SIDS SPANISH
END