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Training Effects of Adaptive Emotive Responses From Animated Agents in Simulated Environments

Enilda Jannet Romero-Hall
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TRAINING EFFECTS OF ADAPTIVE EMOTIVE RESPONSES FROM ANIMATED
AGENTS IN SIMULATED ENVIRONMENTS

by

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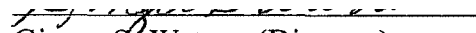
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ABSTRACT

TRAINING EFFECTS OF ADAPTIVE EMOTIVE RESPONSES FROM ANIMATED AGENTS IN SIMULATED ENVIRONMENTS

Enilda Jannet Romero-Hall
Old Dominion University, 2013
Director: Dr. Ginger S. Watson

Humans are distinct from machines in their capacity to emote, stimulate, and express emotions. Because emotions play such an important role in human interactions, human-like agents used in pedagogical roles for simulation-based training should properly reflect emotions. Currently, research concerning the development of this type of agent focuses on basic agent interface characteristics, as well as character building qualities. However, human-like agents should provide emotion-like qualities that are clearly expressed, properly synchronized, and that simulate complex, real-time interactions through adaptive emotion systems.

The research conducted for this dissertation was a quantitative investigation using 3 (within) x 2 (between) x 3 (within) factorial design. A total of 56 paid participants consented to complete the study. Independent variables included emotion intensity (i.e., low, moderate, and high emotion), levels of expertise (novice participant versus experienced participant), and number of trials. Dependent measures included visual attention, emotional response towards the animated agents, simulation performance score, and learners' perception of the pedagogical agent persona while participants interacted with a pain assessment and management simulation.

While no relationships were indicated between the levels of emotion intensity portrayed by the animated agents and the participants' visual attention, emotional

response towards the animated agent, and simulation performance score, there were significant relationships between the level of expertise of the participant and the visual attention, emotional responses, and performance outcomes. The results indicated that nursing students had higher visual attention during their interaction with the animated agents. Additionally, nursing students expressed more neutral facial expression whereas experienced nurses expressed more emotional facial expressions towards the animated agents. The results of the simulation performance scores indicated that nursing students obtained higher performance scores in the pain assessment and management task than experienced nurses. Both groups of participants had a positive perception of the animated agents persona.

Keywords: animated agents, simulations, training, expertise, visual attention, eye tracking, emotional responses, emotion facial coding, performance, nursing



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This dissertation is dedicated to my husband, Mac. Te amo. I also dedicate it to my mom and dad. Thank you for believing in me. Thank you for telling me that I could do anything I set my mind to. Thank you for teaching me to be humble and down to earth.
¡Familia, los llevo en mi corazón por siempre!

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CHAPTER I

INTRODUCTION

Background of the Study

Increased access to the Internet and widespread use of computers in the previous two decades has transformed computer-mediated instruction. Today it is commonplace for instructional environments to use multimedia presentations involving combinations of text, images, animations, and audio, as well as a variety of different instructional approaches such as traditional web- and computer-based instruction, instructional simulations, and serious games. In an effort to improve human-computer interaction and create the illusion of human-to-human interaction, there has also been an increase in the use of animated agents in a variety of these applications.

The focus of this investigation was to expand current knowledge about the role of animated agents in simulated environments. Of particular interest were the effects of emotive, human-like animated agents on visual attention, emotional response, performance, and learners' perception of the animated agent.

What are Animated Agents?

Animated agents are life-like computerized characters designed to facilitate learning in interactive environments (Craig, Gholson, & Driscoll, 2002; Johnson, 2001; Shaw, Johnson, & Ganeshan, 1999). Agents have also been defined as computer programs that simulate a human relationship, by doing something that another person could otherwise do for you (Laurel, 1990; Selker, 1994). The most common agent interface consists of an animated face, a cartoon character, or a human-like virtual agent (Moreno, 2001). They draw their strength from the naturalness of the living-organism

metaphor in terms of both cognitive accessibility and communication style (Laurel, 1990).

The idea of agents is not new. Over the previous decades, numerous researchers have studied the design, development, and implementation of agents (Riecken, 1994). There are varying views on the use of agents in computer-mediated environments. Even the terminology is inconsistent. Various names are used to describe an animated agent; for example: intelligent agents, software agents, guidebots, relational agents, embodied conversational agents, and responsive virtual human to name a few (Riecken, 1994).

Agents occupy a strange place in the realm of technology, generating fear, fiction, and extravaganza (Norman, 1994). The concept of an agent, especially when modified by the terms intelligent, animated, or conversational, brings forth images of human-like androids, working without supervision on tasks thought to be for our benefit but not necessarily to our liking (Gratch et al., 2002; Norman, 1994).

In 1994, Riecken (1994) and Norman (1994) raised several questions and issues about the use of agents. Riecken (1994) and Norman (1994) questioned: How will agents and people communicate with each other? Should an agent be human-like or just be a computer program? How might agents teach people new things? How can agents improve human performance? Can agents improve the creative performance of people? Can agent technology improve collaboration between groups of people? Should agents have emotions? According to Riecken (1994), the future of agents depends on the design and development of rich multimedia environments and the empirical study of these environments with end users. The study of agents presents a unique opportunity to integrate many significant results from many diverse research areas such as cognitive

science, psychology, computer graphics, human-computer interaction and instructional design (Cassell et al., 1999; Clark & Choi, 2005; Gratch et al., 2002; Riecken, 1994).

Role of Animated Agents

In 1994, Selker categorized agents as assistant-style agents and advisory-style agents. The assistant-style agent builds a relationship in which its very success creates dependency for the user (Selker, 1994). On the other hand, the advisory-style agent builds a user relationship with the explicit goal of educating the individual (Selker, 1994).

Today, the use of animated agent surpasses the role of advisor or assistant. Some animated agents are support tools like virtual tutors or help aids to instruct the user to perform a certain task (Hubal, 2008; Johnson, 2001; Kim & Baylor, 2006; Laurel, 1990; Moreno, 2001; Woo, 2009). Others present the instructional content like a virtual instructor training the user (Hubal, 2008; Johnson, 2001; Kim & Baylor, 2006; Moreno, 2001). Some animated pedagogical agents play an acting role to demonstrate examples of concepts and skills or to engage the user in conversation (Hubal, 2008; Kim & Baylor, 2006; Moreno, 2001).

Overall, the role of animated agents is to accurately model the kinds of dialogs and interactions that occur during apprenticeship learning and one-on-one tutoring (Shaw et al., 1999). Additionally, animated agents play a significant part in stimulating social interaction that can facilitate learners to engage in the learning task and consequently to enhance learning in computer-based environments (Kim & Baylor, 2006; Laurel, 1990). As a result, they can be integrated into a variety of interactive media such as web-based information spaces, interactive pedagogical dramas, virtual environments, educational games, and simulations (Johnson, 2001).

Design of Animated Agents

Agents, like anything else, can be well or poorly designed (Laurel, 1990). The aim when designing an animated agent is to create an agent that has a life-like persona (Rickel et al., 2002; Shaw et al., 1999). An agent's behavior and appearance enhances the perception of expertise in the agent (Andre & Rist, 2001; Shaw et al., 1999). Veletsianos (2007) referred to the perception of expertise provided by the agent as contextual relevance. The contextual relevance can be defined as the conformity of an agent's visual characteristics to the content area under which the agent purports to function (Veletsianos, 2007). For example, an agent who looks like a scientist may be perceived to be more competent in science-related disciplines. It is also important that the agent has enough domain knowledge to support the anticipated instructional dialogs with the learner (Shaw et al., 1999).

One of the most valuable aspects of animated agents is the possibility of customizing the agent to represent an ideal social model for a particular user or group of learners (Baylor, 2011). Some key characteristics for designing motivational agents are a pleasant physical appearance, which refers to the age, status, attractiveness, and credibility of the agent (Andre & Rist, 2001; Baylor, 2011; Veletsianos, 2007). Additionally, the agent must have adequate interface agent characteristics such as agency, responsiveness, competence, and accessibility to the learner (Laurel, 1990). Lastly, the agent should present good character building qualities (Gratch et al., 2002; Heckman & Wobbrock, 2000). Character building qualities are animations, gestures, communication, and personality (Baylor, 2011; Heckman & Wobbrock, 2000; Rickel et al., 2002). Behaviors such as gaze, body posture, and tone of voice have a big impact on student's

impressions of agents (Andre & Rist, 2001; Baylor, 2011; Cassell, 2001; Cassell et al., 1998; Johnson, Rickel, & Lester, 2000; Shaw et al., 1999). Combined, these design characteristics give the animated agents the strength needed to make the agent more “believable.” Believability is a suspension of disbelief in which the agent becomes competent, personable, and even alive (Bates, 1994; Heckman & Wobbrock, 2000). Ultimately, the goal of animated agent design is to create an illusion so impenetrable that the user would feel bad about doing anything that might hurt the character (Heckman & Wobbrock, 2000).

To create the essence of life with characters that seem to think, live, and feel; it is critically important that they capture the core of our cultural representations by providing appropriately timed and clearly expressed emotions (Barbat & Cretulescu, 2003; Bates, 1994; Baylor, 2011; Heckman & Wobbrock, 2000; Rickel et al., 2002; Romero & Watson, 2010; Veletsianos, 2009). An animated agent that can effectively convey appropriate emotional responses greatly augment the illusion of life because emotions are something that we find at the heart of what it means to be human (Barbat & Cretulescu, 2003; Bates, 1994; Heckman & Wobbrock, 2000).

Animated agents that draw from a rich repertoire of emotive behaviors to exhibit contextually appropriate facial expressions and expressive gestures can exploit the visual channel to advise, encourage, and empathize with learners (Johnson et al., 2000; Lester, Towns, & Fitzgerald, 1999). Alternatively, an animated pedagogical agent with a rich repertoire of emotive behaviors may simply make learning more fun (Johnson et al., 2000; Lester et al., 1999). A learner that enjoys interacting with a pedagogical agent may have a more positive perception of the overall learning experience and may consequently

choose to remain in the learning environment for a longer period of time (Lester et al., 1999).

Some assume that something so central to humanity, emotions, cannot be replicated due to its complexity (Lester et al., 1999). But it is not emotion that must be replicated in animated agents; it is the appearance of emotion (Lester et al., 1999). By carefully orchestrating facial expression, full-body behaviors, arm movement, and hand gestures, animated agents can be design to visually augment their emotive communication (Lester et al., 1999).

Emotions in Humans

Humans are distinct from machines in the capacity to stimulate and express emotions (Heckman & Wobbrock, 2000). Our emotions define who we are, the relationship we have with others, and our mental and physical well-being (Paul Ekman, 1992, 2007; Heckman & Wobbrock, 2000). Researchers have demonstrated that emotions evolved to prepare humans to deal quickly with the most vital events in our lives (Paul Ekman, 2007; Lang, 2010).

Many researchers have defined emotions and the definitions vary tremendously (Gross, 2010). In fact, the term ‘emotion’ may be one of the “fuzziest” concepts in all of the sciences (Lang, 2010; Lindquist, Siegel, Quigley, & Barrett, 2013; Picard, 1997). The question “What is an emotion?” has been a topic of discussion among philosophers for centuries and for psychologist, anthropologist, and sociologist in more recent decades (Lindquist et al., 2013; Schutz & DeCuir, 2002). There are a variety of reasons for the absence of consensus. A few reasons include: emotions are complex, lay people and scientist use the term in loose and inconsistent fashion, and different scholarly disciplines

that have historically addressed the subject differently (Lang, 2010). For researchers on social emotional interactions, emotions are mostly reactions to other people, which take place in settings where other people are present; they are expressed towards others and are regulated because of other people (Coan, 2010; Fischer & van Kleef, 2010; Gross & Feldman Barrett, 2011; Immordino-Yang, 2010; Stets, 2010). On the other hand, many theories of emotion either imply or assert an underlying neural structure or circuit that organizes and causes a set of outputs such as facial expressions, feelings, actions, and other physiological responses that we call emotional (Coan, 2010; Gross & Feldman Barrett, 2011).

The very nature of emotions, their quality, form, function, and possible universality, has been a matter of theoretical debate and empirical investigation with psychology and other disciplines (Ayers Denham, 2010). The last several decades have produced a virtual explosion of research and theoretical writing on emotion (Feldman Barrett, 2010). The study of emotion began with the fact that humans occasionally experience a salient change in the intensity and valence of a feeling and should award a symbolic name to the feeling (Kagan, 2010). Later scholarship suggested that some feelings have a modest, but imperfect, relational change to facial expressions, voice quality, and voluntary behaviors, and in addition, were often provoked by particular incentives originating in the environment (Kagan, 2010). As the amount of evidence on emotion accumulated, investigators began to argue about other emotion-related topics such as the referential meaning of an emotion (Kagan, 2010), empathy and sympathy (Decety, 2010), emotional development (Camras, 2010a, 2010b; Holodyski & Friedlmeier, 2010; Saarni, 2010), emotional decision making (Loewenstein, 2010; Ohira,

2010), emotional cultures (Stearns, 2010), among other topics. As a result, there is a growing recognition of emotion research with a multidisciplinary approach and dialogue.

Emotion and Learning

As motivation, cognitive, developmental, and educational psychologists have continued to contextualize their inquiry within the education system, it has become clear that emotions are an integral part of education (Schutz & Lanehart, 2002). In the 2000s, researchers interested in teaching, learning, and motivation transactions can no longer ignore emotional activity settings (D. K. Meyer & Turner, 2002; Schutz & Lanehart, 2002). (Eynde & Turner, 2006) The learning process is accompanied by episodes of success and failure which inevitably invoke a host of associated affective responses (i.e., happiness, curiosity, feeling confused, overcoming frustration, hope, determination, enthusiasm) (Craig & Rebolledo-Mendez, 2009). In general, the educational environment creates a context for a variety of emotional experiences that have the potential to influence teaching and learning processes (Schutz & DeCuir, 2002). Emotions serve as a significant element in the learning experience because they play a critical role in attention, planning, reasoning, learning, memory, and decision making, and their influential capability towards perception, cognition, coping, and creativity of the learner (Johnson et al., 2000; Picard, 1997; Um, Song, & Plass, 2007).

Craig and Rebolledo-Mendez (2009) believe that there are empirical and theoretical questions that need to be answered in order to understand the relationship between cognition and affect. For example (Craig & Rebolledo-Mendez, 2009), what are the emotions that are important to learning? Do the relationship between cognition and affect generalize above and beyond individual differences? The next generation of

education researchers needs to be focused on more than just cognition. They will need to investigate educational strategies tailored in order to restore the balance between cognition and affect (Craig & Rebolledo-Mendez, 2009; Picard, 1997). The study of emotion in education has lots of promise when it comes to informing understanding of teaching, motivation, and self regulated learning (Schutz & DeCuir, 2002).

There are several challenges that researchers face when investigating the interplay between emotion and learning (Schutz & DeCuir, 2002; Schutz & Lanehart, 2002). For example, emotions are fluid (Schutz & DeCuir, 2002). They can be quick to occur and quick to change. Additionally, within the educational context emotions may not lend themselves to some traditional investigation methods (Schutz & DeCuir, 2002). For example, it would be very difficult to receive human subjects approval for research in which students were prompted to become angry in order for researchers to study the experience of anger in education. In spite of these challenges, there is an increased interest in inquiry on emotions in learning and researchers have found different approaches for investigating emotion in education (Huk & Ludwigs, 2009; D. K. Meyer & Turner, 2002; Schutz & DeCuir, 2002; Um et al., 2007).

Researchers have applied three approaches to investigate emotions in education (Schutz & DeCuir, 2002). The main type to inquiry on emotion is the investigation of problems with a variable-centered approach. This approach focuses on defining the structure of a concept. For example, most of the work on test anxiety focuses on investigating the structure of the test anxiety construct. Although this variable analysis approach is important for emotion in education research, it is also important to investigate the processes involved in an emotional experience. Thinking about emotions from a

process approach may allow researchers to develop a more fluid understanding of the nature of emotions, how emotions change and develop over time, and the meaning those emotions have to the individuals involved. An approach that has received less attention in investigation of emotions in education is the social-historical contextual aspect of emotions. The hallmark of this approach is the focus on cultural and contextual embeddedness of what occurs in different activity settings.

Schutz and DeCuir (2002) suggest that it might be useful to have different inquiry approaches with an inquiry community such as emotions in education. Using multiple perspectives (i.e., variable-centered, process, and social-historical approach) may allow for a deeper understanding of emotions. However, researchers must be aware that multiple perspectives produce the potential for conflicting as well as convergent findings. The diversity of these findings is also useful to our understanding of emotions in education.

Techniques to assess emotions in education have traditionally included online questionnaires, experience sampling methods, and video-based simulated recall interviews (Eynde & Turner, 2006). However, the use of facial coding systems and registration systems of physiological parameters that capture changes in the motor expression and the neurophysiological components could be used to complement information about a learners' emotion to obtain a more comprehensive picture of an ongoing emotional experience (Eynde & Turner, 2006).

The transition into the affective domain requires innovative approaches to construct models of the emotional dynamics of a learner and efficient use of these models to optimize computer-based learning (Craig & Rebolledo-Mendez, 2009). For example, it

is important to know how researchers can develop and evaluate systems to automatically detect learner-centric emotions in real-time and how learning environments can be modified to be responsive and reactive to the learner's affect (Craig & Rebolledo-Mendez, 2009). Going forward, researchers might investigate the social rules that embodied conversational agents serving as artificial tutors and peer learning companions should employ in order to synthesize affective expressions and yield more naturalistic communication (Craig & Rebolledo-Mendez, 2009).

In 1996, research conducted by Reeves and Nass (1996) established that people interact with computers, television, and new media fundamentally in the same social and natural manner as they do with other people. This is referred to as the "Media Equation." What seems contrary is that media are tools. They help people accomplish tasks, learn new information, or entertain themselves. People do not have social relationships with tools. But it was found that people respond socially and naturally to media even though they believe it is not reasonable to do so (Reeves & Nass, 1996). The "Media Equation" has emotional implications for computer-mediated instruction in that it reveals that human to computer interaction follows similar patterns as human to human interaction.

To further support the need to understand and implement emotion in learning, especially in computer-mediated environment, Picard (1997) suggested the use of affective computing. She proposed the need to give computer interfaces the ability to recognize, express, and in some cases, "have" emotions (Picard, 1997). Affective computing gives the computer interface the ability to respond intelligently to human emotion. Because emotions play an essential role in communication, a quantum leap in

communication will occur when computers are able to recognize and express affect (Picard, 1997).

Currently, little empirical research on users' emotions and their effect on learning performance is available that could guide the design of learning environments (Um et al., 2007). Emotions have been used as outcomes of instructional design but rarely as factors that influence the learning process and cognition. As suggested by Um et al. (2007), emotional design principles should be studied in more detail to allow for the design of better instruction.

The Problem Statement

Because emotions can play such an important role in human interactions, human-like agents used in pedagogical roles for simulation-based training should properly reflect emotions. Current research concerning the development of this type of agent focuses on basic agent interface characteristic as well as character building qualities. Human-like agents should also provide emotion-like qualities that are clearly expressed, properly synchronized with all character building qualities, and that simulate complex, real-time interactions through adaptive emotion systems.

The purpose of this dissertation research was to investigate the effects of emotionally responsive agents represented as emotionally distressed clients during simulation-based training. Specifically, this research assessed how adaptive, emotionally responsive animated agents affect the perception and instructional outcomes of individuals interacting in a real-time training simulation with emotionally distressed clients. This research informs current literature on animated agents and simulation design for training personnel who interact with emotionally distressed clients. The research is

strengthened by the use of objective, physiological measures such as visual attention and emotion response measured using eye tracking and an emotion Face Reader system.

Professional Significance of the Study

The professional significance of this dissertation research is that it examined the application of animated agents in a simulated environment using domain specific context and participants. The topic of the simulation used in this research is specific to the healthcare field, specifically to pain assessment and management. The recruitment of participants was limited to nursing students and professional nurses. Due to its domain-specific content, the results of this study are valuable to both instructional designers and nurse educators. The results from this dissertation research also help improve development of real-time simulations in fields as diverse as healthcare, mental health, emergency response, law enforcement, and the military.

Another professional significance of this dissertation research is the use of physiological measures. Previous studies on the application of animated agents in education and training have returned conflicting evidence. The use of physiological measures like eye tracking and a facial expression coding system to measure visual attention and emotion responses, respectively, have not been widely used to study the application of animated agents in computer-mediate environments. This dissertation research can provide some insight into the use of physiological measures to understand learners' processing of visual stimuli, such as animated agents.

Lastly, this dissertation research has intrinsic importance, affecting learners' social interactions in computer-mediated environments. As the design and development of simulations evolves to more realistic environments, the use of efficient, human-like

animated agents will play a significant role in the success of instruction and training.

Emotions as well as other character building qualities (i.e., animation, communication, and gestures) will be of great importance to the realism of the social interactions with animated agents.

CHAPTER II

LITERATURE REVIEW

A large body of literature on the nature of simulations, animated agents, physiological measures (i.e., visual attention and face expression reading), expertise performance, and pain management provides the basis for the present dissertation research. This chapter explains the theoretical and empirical studies related to the previously mentioned areas of study, which help support the hypothesis and research questions of this dissertation research.

Simulations

Alessi (2000) defined instructional simulations as programs that incorporate a model that a learner can manipulate and for which the learning objective includes understanding the model through interaction with the simulation. For training, simulations are used to engage the participants in different types of actions and decision-making processes (Gredler, 1994; Kriz, 2003; Martin, 2000). They are perceived as more interesting and motivating than other methodologies for learning because they provide a real-world perspective (Alessi, 1988; Alessi & Trollip, 2001; Martin, 2000). Simulations can be used to acquire new knowledge and provide an opportunity to apply knowledge in a variety of situations (Curtin & Dupuis, 2008). Simulations can increase students' critical thinking, decision making, and problem solving skills (Curtin & Dupuis, 2008).

Most simulations have a cooperative nature, requiring participation from students and teachers. They have potential for experiential learning and they require deep engagement by participants (Cannon-Bowers & Bowers, 2008; DeLeon, 2008; Schmidt, 2003). In simulated environments learners are able to experience the function of an

authentic role, including the decisions and consequences encountered in playing that role (Chua, 2005; Kriz, 2003; Martin, 2000). Additionally, most simulations attempt to keep learners in the “flow state.” The flow state refers to the situation in which the challenges presented and the learners’ ability to solve them matches accordingly (Chua, 2005). Overall, a well-designed computer-based simulation can be the ideal tool for safely enabling students to conduct and re-conduct experiments in virtually any given period of time (Liu & Su, 2011). Computer-based simulations are substantially more detailed, more realistic, and more sophisticated than traditional pencil and paper simulations (Schmidt, 2003).

It is important to recognize that a simulation is not technology, but rather an educational strategy (Anderson, Aylor, & Leonard, 2008). An educational strategy describes the methods by which educational content is delivered (Anderson et al., 2008). Educational strategies should be chosen based on how well they can meet learning objectives (Anderson et al., 2008). Simulation, as an educational technology strategy, can be used to effectively meet the following types of learning: cognitive (knowledge and problem solving), affective (attitudinal), and psychomotor (technical skills, behavioral skills, and performance) (Anderson et al., 2008). In simulated experiences, the instructor must first identify the learner and the learning needs, and then construct simulations that provide balanced challenge and support in order for the greatest learning to occur (Anderson et al., 2008).

Simulation Fidelity

The term fidelity refers to the level of realism that a simulation presents to the learner (Choi, 1997; Feinstein & Cannon, 2002). This concept is an integral component in

a simulation because it defines how similar a training or instructional situation must be, relative to the operational situation, in order to train most efficiently (Cannon-Bowers & Bowers, 2008; Feinstein & Cannon, 2002). The degree of fidelity in a learning environment is a difficult element to measure (Feinstein & Cannon, 2002). Many authors studied the relationship between fidelity and its effects on training and education (Alessi, 1988, 2000; Alessi & Trollip, 2001; Choi, 1997). Researchers have stated that a higher level of fidelity does not equate more effective training or enhanced learning (Alessi, 1988, 2000; Alessi & Trollip, 2001; Choi, 1997). In fact, lowered fidelity actually can assist in acquiring the details of training and education (Alessi, 1988; Cannon-Bowers & Bowers, 2008). This is supported by additional research that determined that high fidelity can actually hinder effective training and learning because it over stimulates novice learners (Choi, 1997).

Types of Simulations

According to Gredler (1994), there are two major types of simulations used for education and training. They are tactical-decision simulations and social-process simulations. The tactical decision simulations are sub-divided into diagnostic, crisis management, and data-management simulations (Gredler, 1994). In these types of simulations the participant engages in the selection and interpretation of data, implementation of a strategy, and resource allocation activities to solve a problem or crisis (Gredler, 1994). Social-process simulations, on the other hand, are subdivided into social-system, language skills/communication, and empathy/insight simulations (Gredler, 1994). In the social-process simulations the focus is on the various interactions involved in pursuing social goals (Gredler, 1994). The participants utilize a range of strategies

such as interviewing, writing, questioning, negotiation, persuasion, and confrontation in an attempt to achieve their social objectives (Gredler, 1994).

There are other experts in the field who present a different categorization of simulations for education and training. For example, Alessi and Trollip (2001) stated that simulations are actually divided into physical, iterative, procedural, and situational simulations. Physical and iterative simulations are those that teach “about” something whereas, procedural and situational simulations teach the participants “how to do” something.

Affordances of Simulations

Regardless of the different types of categorizations assigned by experts in the field, instructional simulations in general provide significant learning affordances that can enhance a participant’s learning experience. Computer-based simulation can track and organize the information of each student. For example, a computer-based simulation can track the decisions, in sequence, made by all student during the simulation interaction process (Schmidt, 2003). Also, computer-based simulations can perform mathematical calculations quickly, allowing the simulation to be based on complex, instructive models of different fields (Schmidt, 2003). For remote interaction, computer-based simulations allow students to work cooperatively with other students who they may not otherwise reach (Schmidt, 2003). The Internet allows for large groups to interact in a simulated environment (Schmidt, 2003). This is a great benefit for distance learning classes, as learners may use a web-based simulation to interact with one another. In this scenario, instructors can teach collaboratively with colleagues at different institutions, while

learners in classes at each school can participate in the simulation together (Schmidt, 2003).

There are other advantages to the use of simulations compared to real life scenarios. Simulations can be used to create a scenario that is a safety concern for learners, for example a nuclear power plant disaster (Alessi & Trollip, 2001; Cannon-Bowers & Bowers, 2008). Similarly, simulations can be used to represent rare events in everyday life (i.e., a natural disaster location) or events that are not readily available in reality (Alessi & Trollip, 2001; Cannon-Bowers & Bowers, 2008). Simulations can also be used when actual equipment cannot be employed or to eliminate the cost of conducting training on operational equipment (Cannon-Bowers & Bowers, 2008).

In nursing and medical education, simulations provide students with an opportunity to work through situations they may not experience during their clinical rotations (Curtin & Dupuis, 2008). In fact, simulation-based training improves recall in authentic clinical situations, as well as familiarization with medications, instruments, and medical equipment that enhances learners performance (Anderson et al., 2008). It can prepare students with intensive care and emergency experiences (Curtin & Dupuis, 2008). There is evidence that simulation can be used to assess novice versus expert differences in nursing and medical simulation performance (Anderson et al., 2008).

Advances in computer-based simulation software now allow the development of agents to support realistic social interactions (Rickel et al., 2002). “Agents” refers to virtual entities that possess some degree of autonomy, social ability, reactivity, and proactiveness (Stanney & Cohn, 2006). They can take many forms (i.e. human, animal) that are rendered at various levels of detail and style, from cartoonish to physiologically

accurate models (Stanney & Cohn, 2006). Agents provide important affordances of simulation applications involving interactions with other entities, such as adversaries, partners, instructors, or learners (Hubal, 2008; Johnson, 2001; Rickel et al., 2002; Stanney & Cohn, 2006). In healthcare simulations, in particular, agents play a very important role as simulated patients, family members, or healthcare team members. They provide four main advantages: availability for interaction with the participant at all times; the avoidance of physical or mental trauma to humans when interacting with an inexperienced student; the ability to practice the same action without any differences between interactions or individual participants, and the ability to portray with high fidelity any physical or mental trauma without causing harm to real life humans (Baylor, 2011; Gredler, 1994; Hubal, Frank, & Guinn, 2000; Hubal, Kizakevich, Guinn, Merino, & West, 2000; Kizakevich, Lux, Duncan, & Guinn, 2003).

Animated Agents

Animated agents are used in simulation-based learning environments to support learning (Elen, Clarebout, & Johnson, 2002; Kim, Baylor, & Group, 2006). They represent a new paradigm for education and training in interactive learning environments, providing a new metaphor for human-computer interaction based on face-to-face dialogue (Andre & Rist, 2001; Bickmore & Picard, 2003; Cassell et al., 1998, 1999; Johnson, 2001; Johnson et al., 2000; Kim & Baylor, 2006). Most animated agents act as coaches and provide support on the level of the content and problem solving (Elen et al., 2002). All agents used in learning environments, thus far, are technologically able to communicate both verbally and non-verbally (Cassell et al., 1998, 1999; Clark & Choi, 2005; Elen et al., 2002; Johnson, 2001). Most agents use speech (Elen et al., 2002). Some

use both speech and text (Elen et al., 2002). The most frequently used delivery modality is dialogue, in which the agent provides explanation and complements the interaction with questioning (Elen et al., 2002). Pedagogical agents can deliver learning support either up front, just-in-time, or delayed (Elen et al., 2002). Most commonly, animated agents use just-in-time timing to deliver support during the learning process (Elen et al., 2002).

Agents with names such as Adele, Steve, Herman the Bug, Cosmo, and Rea have been developed to serve a variety of instructional goals in computer-based instruction (Clark & Choi, 2005; Elen et al., 2002; Johnson et al., 2000; Shaw et al., 1999). These animated agents have been used to facilitate tutoring system architectures, provide assistance to trainers in virtual worlds, and act as co-learners (Kim & Baylor, 2006; Lester et al., 1999).

Adele was designed to support students working through problem-solving exercises that are integrated into instructional materials delivered over the Internet (Johnson, 2001; Johnson et al., 2000; Shaw et al., 1999). In a case-based clinical diagnosis application, students are presented with materials on a particular medical condition and are then given a series of cases that they are expected to work through (Johnson, 2001; Shaw et al., 1999). Adele is used to highlight interesting aspects of the case, monitor and provide feedback as the student works through a case, give hints or rationale for particular actions, or quiz the students to make sure the students understands the principles behind the case (Johnson, 2001; Shaw et al., 1999).

Steve was designed to interact with students in a network immersive virtual environment and has been applied to naval tasks such as operating the engines aboard US

Navy surface ships (Johnson, 2001; Johnson et al., 2000). Steve supports individual and team training (Johnson, 2001; Rickel et al., 2002). He can advise learners as they perform roles within teams, and it can even play the role of a missing team member (Johnson, 2001; Rickel et al., 2002). Like other animated agents, Steve can monitor students' actions, point out errors, and answer question (Johnson, 2001; Rickel et al., 2002). He can demonstrate actions, use gaze and gestures to direct the student's attention, and guide the student around the virtual environment (Johnson, 2001; Rickel et al., 2002).

Herman the Bug inhabits Design-A-Plant, a learning environment for the domain of botanical anatomy and physiology (Johnson et al., 2000). Given a set of environmental conditions, children interact with Design-A-Plant by graphically assembling customized plants that can thrive in those conditions (Johnson et al., 2000). Herman is a talkative, quirky insect that dives into plant structures as he provides problem-solving advice to students. As the students build plants, Herman observes their actions and provides explanations and hints. In the process of explaining concepts, Herman performs a broad range of actions, including walking, flying, shrinking, swimming, and other acrobatics (Johnson et al., 2000).

Cosmo was designed to provide problem-solving advice in the Internet Protocol Advisor environment. Students interact with Cosmo as they learn about network routing mechanisms by navigating through a series of subnets. By making decisions about factors such as address resolution and traffic congestion, users learn about the fundamentals of network topology and routine mechanisms. Cosmo has the ability to dynamically combine gestures, locomotion, and speech to refer to objects in the environment while delivering problem-solving advice.

Rea is an embodied, multimodal real-time conversations agent (Bickmore & Cassell, 2000; Cassell, 2001; Cassell et al., 1998, 1999; Cassell, Bickmore, Campbell, Vilhjálmsón, & Yan, 2001). It implements the social, linguistic, and psychological conventions of conversation to make interaction with a computer as natural as face-to-face conversation with another person (Bickmore & Cassell, 2000; Cassell et al., 2001). Rea is an acronym for “Real Estate Agent,” and within this domain it focuses on modeling the initial interview with a prospective buyer (Bickmore & Cassell, 2000; Cassell et al., 1998, 1999; Cassell et al., 2001). Rea has a human-like body and uses her body in human-like ways during the conversation (Bickmore & Cassell, 2000; Cassell, 2001; Cassell et al., 1999; Cassell et al., 2001). She uses eye gaze, body posture, hand gestures, and facial displays to organize and regulate conversation (Bickmore & Cassell, 2000; Cassell, 2001; Cassell et al., 1998, 1999; Cassell et al., 2001).

Benefits of Animated Agents

Discussions about the uses of agents in computer-based instruction suggest that they might have at least three primary types of learning benefits (Baylor, 2011; Clark & Choi, 2005). First, agents may have a positive impact on learners’ motivation and how strongly they value computer-based learning programs (Baylor, 2011; Clark & Choi, 2005). Second, animated agents might help learners focus on important elements of learning materials (Clark & Choi, 2005). Lastly, agents may also provide learners with context-specific learning strategies and advice (Clark & Choi, 2005; Johnson, 2001).

There are other benefits provided by animated agents. One of these benefits is that the agent can demonstrate physical tasks, such as operation and repair of equipment (Johnson et al., 2000). Demonstrating a task may be far more effective than trying to

describe how to perform it, especially when the task involves spatial motor skills (Johnson et al., 2000). An interactive demonstration using an animated agent provides the students the ability to move around in the environment and view the demonstration from different perspectives (Johnson et al., 2000). Agents can also demonstrate procedures performed by complex devices by taking on the role of an actor in a virtual process (Johnson et al., 2000).

When a student's work environment is large and complex, animated agents are valuable as navigational guides, leading students around and preventing them from becoming lost (Johnson, 2001; Johnson et al., 2000). Research on training using immersive virtual reality shows that students can easily become disoriented and lost in complex environments making animated agents that serve as guides important instructional aides (Johnson et al., 2000). Learning environments with navigational guides can help students develop spatial models of the subject matter (Johnson et al., 2000).

Another benefit of animated agents is their ability to serve as the learners' attentional guides using the most common and natural methods: gaze and deictic gesture (Johnson et al., 2000). Because of significant advances in the capabilities of graphics technologies in the past decade, interactive learning environments increasingly incorporate visual aids (Johnson et al., 2000). Animated agents can use gaze and gestures to draw students' attention to a specific aspect of a chart, graphic, or animation (Johnson et al., 2000). Agents can employ deictic behaviors to create context-specific references to physical objects in virtual worlds (Johnson et al., 2000).

Two behaviors related benefits of animated agents are their ability to provide non-verbal feedback and conversational signals. One primary role of animated agents is to provide feedback on a student's action (Hubal, 2008; Johnson et al., 2000). The ability to provide non-verbal feedback in addition to verbal comments allows an animated agent to provide more varied degrees of feedback (Cassell et al., 1998; Johnson et al., 2000). For example, a simple head nod to show agreement can assure a student without interrupting them. Non-verbal feedback is less obtrusive than a verbal comment (Johnson et al., 2000). Animated agents can also use non-verbal signals to help regulate conversations with students and complement their verbal utterances (Bickmore & Cassell, 2000; Cassell et al., 1998; Johnson et al., 2000). For example, the animated agent can use an intentional pitch accent to highlight a salient word or phrase. Although, communication can happen in the absence of these non-verbal signals, it proceeds most smoothly when they are available (Bickmore & Cassell, 2000; Johnson et al., 2000). If the bodies of the animated agents are used in ways that leverage knowledge of human communication behavior, animated agents will provide a qualitative advantage over other types of interfaces (Cassell et al., 2001).

One last benefit of animated agents is their ability to motivate the learner by properly conveying and eliciting emotion (Johnson, 2001; Johnson et al., 2000; Kim & Baylor, 2006; Rickel et al., 2002). An agent that appears to care about a student's progress may encourage the student to care about their own progress (Johnson et al., 2000). Additionally, an emotive agent may convey enthusiasm for the area of the instruction and therefore foster similar levels of enthusiasm in the learner (Andre & Rist, 2001; Hubal, 2008; Johnson et al., 2000; Rickel et al., 2002). Overall, the quality, clarity,

and dramatic impact of communication can be increased through the creation of emotive movements that underscore the affective content of the message (Johnson et al., 2000). Therefore, as animation of emotions becomes more sophisticated, animated agents are better positioned to improve student's motivation (Johnson et al., 2000).

Research on Animated Agents and Learning

Despite the claimed benefits, the results of the published empirical studies on animated agents are varied and the findings are inconclusive (Adcock, Duggan, Nelson, & Nickel, 2006; R. K. Atkinson, 2002; Baylor, 2002; Baylor & Ryu, 2003; Clarebout & Elen, 2006; Craig et al., 2002; Dirkin, Mishra, & Altermatt, 2005; Kim et al., 2006; Moreno, 2001; Moreno, Mayer, & Lester, 2000; Ryokai, Vaucelle, & Cassell, 2003; Yung, 2009). Some studies have found that under certain conditions animated agents may distract learners, overload them cognitively, or even suppress learning (Baylor & Ryu, 2003; Clark & Choi, 2007; Craig et al., 2002; Dirkin et al., 2005). Craig et al. (2002) used an animated agent to investigate issues related to attention by manipulating the agent properties (i.e., agent, agent with gestures, no agent) and features of the pictorial information presented along with the agent (i.e., static picture, sudden onset, animation). The results revealed that there was no difference in learners' attention between the agent and the no agent condition (Craig et al., 2002). However, there were important limitations of these findings including the short information delivery time (i.e., 180 seconds) and the lack of participants' selected domain knowledge (Craig et al., 2002).

In a different investigation, Dirkin et al. (2005) researched the levels of social richness of an agent's behavior using four experimental conditions (i.e., text only, voice only, image of an agent plus voice, social agent). The results of the study were surprising

in that the participants perceived higher degrees of social presence at both ends of the sociability continuum, the text only condition and the fully social agent condition (Dirkin et al., 2005). Participants had a more positive perception of the learning experience in the text only condition and there was not a significant effect of the experimental manipulation on performance (Dirkin et al., 2005). The investigators stated that the presence of graphics, text, and voice in the image and voice condition may have produced a split attention effect and possibly a redundancy effect.

Baylor and Ryu (2003) investigated animation, a key aspect of agent persona. This investigation used three conditions to compare the design of an animated agent: no image, static, and animated (Baylor & Ryu, 2003). Results indicated that the animated condition provided the most positive impact for an agent to be perceived as engaging, person-like, instructor-like, and credible (Baylor & Ryu, 2003). However, no effects were found between the three conditions on performance (Baylor & Ryu, 2003). The results of this study provide some clarification towards the role of animation in agents. However, it did not provide the desired learning outcome, which is a key consideration for instructional designers implementing agents.

The results of these studies accentuate the need for careful design of animated agents used in instructional software to ensure that the agents enhance rather than detract from the learning experience. The question left by these studies is: why does an animated agent, as supporting means to human teaching, fail to produce positive results to achievement gains? Perhaps, the presence of an animated agent adds a more dynamic computer interface which complicates the way learners perceived the information

presented (Woo, 2009). Possibly, the role of animated agents resemble that of a human and therefore face the same kind of complexity as a human companion (Woo, 2009).

There are few studies that highlight the use of an animated agents as a factor contributing to higher learning scores and/or a more positive attitude towards the learning experience (Arslan-Ari, 2010; Baylor, 2002; Clarebout & Elen, 2006; Kim et al., 2006; Moreno, 2001; Moreno et al., 2000; Ryokai et al., 2003; Yung, 2009). Moreno et al. (2000) compared the same interactive environment with and without an animated agent. The results demonstrated that both groups learned the basic factual information. However, the participant in the interactive environment with an animated agent produced significantly more correct solutions on transfer problems. These findings give preliminary evidence in favor of using animated agents as companions in interactive learning environments. Moreno et al. (2000) also confirmed the importance of the animated agent's communication via speech in a dialogue format as a method to motivate students.

Yung (2009) investigated the effects of an animated agent providing verbal and visual prompts to facilitate student achievement. This study found that students performed better when they accessed the animated agent with visual prompts. The students in the visual prompts group outperformed the verbal prompts group on the comprehension and terminology tests. The theoretical implications of these findings are that the students who accessed the animated agent with visual prompts extracted meanings from both the pictures and text resulting in better comprehension of the instruction. The animated agent in this investigation was significantly more effective in facilitating student achievement on a comprehension test that required a deeper level of

information processing for comprehension of the instructional material (Yung (2009).

This suggests that animated agents may be most effective at facilitating critical thinking and problem solving processes.

Animated agents have also proven to be successful when used to address the discourse genre of storytelling as a bridge to improve literacy. Ryokai et al. (2003) conducted an investigation in which children played with practice storytelling in the context of peer collaboration to learn language skills important for literacy. In the investigation, participants were assigned to one of four treatments (i.e., without an agent, with an agent, with a playmate, with a playmate and an agent) (Ryokai et al., 2003). Results indicated that the presence of the animated agent as a storytelling partner dramatically increased the frequency with which children used quoted speech and temporal and spatial expressions (Ryokai et al., 2003). By taking turns with the animated agent and by listening to the animated agent's stories, the children's stories became more sophisticated and explicit (Ryokai et al., 2003). This work supports the role of animated agents' ability of reproducing social learning interactions.

To study the effect of an animated agent in an open learning environment, Clarebout and Elen (2006) conducted an investigation in which participants were randomly assigned to one of three conditions: animated agent with adapted advice, animated agent with non-adapted advice, and a control group (Clarebout & Elen, 2006). The findings from the investigation revealed that the participants assigned to the animated agent with non-adapted advice outperformed participants in the control group (Clarebout & Elen, 2006). In other words, an agent providing adapted advice did not

result in better performance. However, the results do show that an agent can indeed contribute to learning in an open learning environment.

The results of these studies are important because they reveal that animated agents are regarded as social members similar to humans and they are more effective in engaging learners in environments that require social communication and interactions (Clarebout & Elen, 2006; Ryokai et al., 2003; Yung, 2009). The results suggest that if used appropriately, animated agents produce more definitive results in terms of learning and affect (Woo, 2009). It is critical to note that the positive effects from these studies were based on proper integration of the agent's behavior, the instructional approach, and an amalgamation of pedagogy and interface design.

Although most research on animated agents supports or denies the benefits of these human-like animated characters, a few studies have provided mixed results on learners' achievement and perception when measuring the presence of an animated agent (Adcock et al., 2006; R. K. Atkinson, 2002; Baylor, 2002). Baylor (2002) investigated how the presence of animated agents (i.e., constructivist agent and instructivist approach) affect students' metacognitive awareness, performance, and attention during instructional planning. The results indicated that the presence of the constructivist agent was associated with the development of more constructivist-oriented instructional plans, reflecting a trickle-down effect of the agent's pedagogical beliefs on the participant (Baylor, 2002). However, there were no overall effects of the agents on attitude or on the overall performance score (Baylor, 2002). Given that the performance measures were based on the instructional plan created in the interactive learning environment, perhaps

different post-test measures of near and far transfer of learning would be more appropriate (Baylor, 2002).

Similarly, Adcock et al. (2006) conducted an investigation in which a web-based helper-client script and an active participation performance-based learning environment with an animated agent were used to teach effective helping skills to human service students. The results of the study indicated that both environments increased the communication skills acquisition of the participants (Adcock et al., 2006). Additionally, the ability of learners to discriminate between effective responses decreased in both treatments (Adcock et al., 2006). However, there was no significant difference in user perception of the systems' motivation, knowledge development, interest, helpfulness, and believability (Adcock et al., 2006).

Overall, these studies support the effectiveness of an agent-based approach to facilitate teaching and learning. Further, these studies provide preliminary evidence that agent-based learning environments can facilitate the promotion of metacognitive awareness (Baylor, 2002) and help discrimination skills (Adcock et al., 2006). However, the lack of learning in some studies and differences in perceptions based on the presence of an animated agent suggest that there are certain shortcomings that future research needs to explore. Clark and Choi (2005) suggested that mixed results in research studies related to animated agents are largely due to the way that studies are designed. Adequate design and a concern for current theories of learning and instruction will help develop accurate evidence for the impact of agents on transfer of knowledge and perceptual data.

Research on Emotionally Expressive Animated Agents

An entertaining and compelling animated agent must express emotion (Rickel et al., 2002). Emotional behaviors are used to create a sense of empathy and drama and to fill the agents with a rich mental life (Gratch et al., 2002; Rickel et al., 2002). The growth in emotional agent-based interactive learning environments builds on the theory that entertainment value translates into greater student enthusiasm for instruction and better learning (Rickel et al., 2002). But beyond creating a sense of engagement, emotion appears to play a central role in teaching (Rickel et al., 2002). As a result, research on emotion models has increased in recent years (Rickel et al., 2002). This work is motivated by psychological theories of emotion that emphasize the relationship between emotions, cognition, and behaviors (Gratch et al., 2002; Rickel et al., 2002).

Bickmore and Picard (2004) conducted studies (Bickmore & Picard, 2004; Bickmore & Picard, 2005) based on psychological theories of emotions that focused on the human-computer relationships using a caring, relational animated agent. According to Bickmore and Picard (2004) feeling that one is cared for has profound effects on physiological cognition and emotional state in humans. Caring is expressed not only through speech content, but through non-verbal and paraverbal modalities including facial expression, posture, and tone and timing of speech (Bickmore & Picard, 2004). The research conducted by Bickmore and Picard (2004) consisted of an animated agent that played the role of an exercise advisor helping learners through a behavior change program designed to increase the learners' physical activity levels. The human-like agent, Laura, included speech and non-verbal behaviors such as hand gestures, eye gaze behavior, posture shifts, head nods, proximity, and facial expressions (Bickmore &

Picard, 2004; Bickmore & Picard, 2005). In the interactive environment the animated agent, Laura, provided feedback on the exercise behavior of the learner, helped the learners overcome obstacles to exercise, provided educational content related to exercise, and followed up on commitments to exercise (Bickmore & Picard, 2004; Bickmore & Picard, 2005).

In their study, Bickmore and Picard (2004) compared an interactive environment with a relational agent and another environment with a non-relational agent. The results indicated that participants felt that the agent cared about them, was genuinely concerned about their welfare, and that the agent liked them (Bickmore & Picard, 2004; Bickmore & Picard, 2005). The results of the month-long study implied that a relational agent can have a significant impact on people's perception of caring (Bickmore & Picard, 2004; Bickmore & Picard, 2005).

Another study that integrated psychological theories of emotions using emotional animated agents was conducted by (Kim, Baylor, & Shen, 2007). Kim et al. (2007) investigated the impact of an animated agent's emotional expression on learner's affective and cognitive characteristics. The animated agents used in this study were male and a female agents (Kim et al., 2007). The emotional expressions of the agents were achieved through verbal and facial expressions, tone of voice, and head movements (Kim et al., 2007). The animated agent's had three emotions: positive, negative, and neutral. In the positive emotion the agents had a happy, smiling face and an engaging posture, with eye contact and head nodding (Kim et al., 2007). In the negative emotion, the agents had a somber and rather frowning face and an aloof posture with evasive eye gaze and less head nodding (Kim et al., 2007). The emotional states of the agents were clearly

communicated to the learners to ensure the validity of the findings (Kim et al., 2007). The neutral condition of the agents did not express emotions at all (Kim et al., 2007).

The results of the investigation showed that the positive emotional state of the male agent significantly influenced the learner's social judgment of the agent (Kim et al., 2007). Also, when the male agent expressed a positive emotion, the learners showed higher interest on the content of the instruction (Kim et al., 2007). Overall, the study showed that the learner's affective characteristics were influenced by the digital peer's emotion, as in the case of peer-to-peer interaction (Kim et al., 2007). One shortcoming of this study was that the emotional state did not change the learner's achievement level. According to Kim et al. (2007), this investigation confirmed that "smiley faces" may make a learner smile but may not be sufficient to increase learning. However, it is important to note that one possible reason (for not having an increase in learning) might be the lack of range in the animated agents' emotions (Kim et al., 2007). The agents expressed one constant type of each condition: happy, sad, or neutral, throughout the module (Kim et al., 2007).

Veletsianos (2009) also conducted an investigation focused on the animated agents' expression of emotion. In the investigation, Veletsianos (2009) compared two versions of a tutorial lesson that differed in terms of verbal expressiveness. In the expressive version of the tutorial lesson, the agent emphasized certain parts of speech by including additional pauses, instances where the content was delivered in a louder voice, and instances where words were more enunciated (Veletsianos, 2009). In terms of the agent's non-verbal behaviors, gaze was predetermined and eye and eyebrow movement were coordinated (Veletsianos, 2009). The findings of this research, much like the other

studies on emotionally expressive animated agents, showed that the expressive agent's interaction ability was rated more favorably than the non-expressive agent's interaction ability (Veletsianos, 2009). In addition, the results indicated that the participants in the expressive agent group increased their learning outcomes compared to the participants in the non-expressive agent group (Veletsianos, 2009).

Veletsianos (2009) showed that the impact of animated agents research and advances will be minimal if agents are designed to deliver pre-recorded and dispassionate lectures. The future of animated agents needs to focus on transforming content to engage and capture student attention. According to Veletsianos (2009), instructional designers should focus on designing efficient and effective instructional learning experiences rather than designing media.

As human-animated agent interaction becomes more common, it becomes more important that the interactive learning environments rely on the same interactional rules that humans use with each other (Cassell, 2001). The purpose is not just to add animated agents for prettiness; they are often not particularly pretty at all, but to leverage learners' natural tendencies to attribute humanness to the animated agent.

The lesson learned from research on animated agents is that well-designed agent-based interactive learning environments provide visual cues to their users that help them understand the rules of the environment. (Cassell, 2001). Humans provide very strong visual cues about the protocols that they engage in, protocols that must be integrated into the very heart of a system in order for animated agents to respond with appropriate surface-level behaviors (Cassell, 2001). Unfortunately, many of the agent-based interactive learning environments consist of an animated agent inserted into an existing

system. They are capable of portraying a series of communicative poses without attention to how humans actually convey their knowledge of the world and of human interactions to their interlocutors (Cassell, 2001). Such systems represent an enormous missed opportunity.

Visual Attention

We use eye movements to analyze our environment, including instructional presentations, and to make sense of what we are looking at (Holsanova, Holmberg, & Holmqvist, 2009). These movements provide researchers with non-invasive, sensitive, and real-time evidence of ongoing visual and cognitive processing (Holsanova et al., 2009). They can provide insight into the allocation of our attentional resources (Holsanova et al., 2009), in particular when learning from written texts, graphics, and animations (Hyönä, 2010). The link between the direction of human gaze and the focus of attention is called the eye-mind hypothesis (Hyönä, 2010). According to this hypothesis, people attend to and process the visual information that their gaze is currently focused on, as long as the visual environment in front of their eyes is pertinent to the task at hand (Hyönä, 2010).

Research using Visual Attention Measures

For the field of learning and instruction, visual attention research is a very promising methodology that facilitates measurement of human information processing (Canham & Hegarty, 2010; Holsanova et al., 2009; Hyönä, 2010; Louwerse, Graesser, McNamara, & Lu, 2009; Mayer, 2010; Scheiter & van Gog, 2009; van Gog & Scheiter, 2010). Researchers have used it to investigate reading of information graphics (Holsanova et al., 2009). Holsanova et al. (2009) used a naturalistic newspaper-reading

task to study how readers choose entry points, their readings paths, and optimum integration of text and graphics. The results of this study on reader's comprehension of information graphics showed that reading time, reading order, and the number of fixations correlated significantly with comprehension (Holsanova et al., 2009). This study helped examine the cognitive process involved in text-picture integration and provided insight on the application of printed media and textbook design (Holsanova et al., 2009).

Another area of investigation in the field of learning and instruction using eye tracking methodology is the study of complex graphics (Canham & Hegarty, 2010). Canham and Hegarty (2010) conducted an eye tracking experiment using weather maps as complex graphics, the maps integrated both relevant and irrelevant information. The tasks required participants to encode information from the display and it also required them to make inferences from the information presented in the map (Canham & Hegarty, 2010). The results from the eye tracking data determined that after learning relevant meteorological principles, participants spend more time viewing the most task relevant areas of the maps and less time viewing the task irrelevant areas (Canham & Hegarty, 2010). This study provided insight into how knowledge and display design affect the comprehension of complex graphics.

The eye tracking methodology used by the researchers in these studies offers a unique opportunity to understand the learners' perceptual processing. According to Mayer (2010), eye tracking methodology offers a tool for testing hypotheses about perceptual processing during learning under different instructional methods.

Computer-Mediated Instruction Research using Visual Attention Measures

Recent pioneering researchers have investigated the use of computer-mediated instruction with eye tracking technology (Alkan & Cagiltay, 2007; Boucheix & Lowe, 2010; de Koning, Tabbers, Rikers, & Paas, 2010; Hyönä, 2010; K. Meyer, Rasch, & Schnotz, 2010; Scheiter & van Gog, 2009; Schmidt-Weigand, Kohnert, & Glowalla, 2010; Schwonke, Berthold, & Renkl, 2009; van Gog & Scheiter, 2010). Because eye tracking provides insight into the allocation of visual attention, it is highly suited to studying differences in attentional processes evoked by different types of multimedia and multi-representational instructional material present in computer-mediated instruction (van Gog & Scheiter, 2010). Similar to reading studies using eye tracking methodology, research on multimedia and multi-representations in computer-mediated environments using eye tracking provides unique information concerning what medium and representations are visually attended to, for how long, and in what order (van Gog & Scheiter, 2010).

van Gog and Scheiter (2010) documented three techniques in which eye tracking methodology improves computer-mediated instruction. First, eye tracking can be used to better understand the familiar negative multimedia learning effects such as split-attention effect, modality effect, and redundancy effect (van Gog & Scheiter, 2010). In this technique, eye tracking methodology can corroborate the presence of such effects in the multimedia content. Secondly, eye tracking methodology may provide insight into how learners process certain multimedia and multi-representation materials (van Gog & Scheiter, 2010). Therefore, eye-tracking data may improve the design of multimedia materials. Lastly, van Gog and Scheiter (2010) explained that eye tracking data can be

instructional material itself. In other words, eye tracking data could be made accessible to the learners so that they can self-assess their own eye movement performance in a computer-mediated environment (Kostons, van Gog, & Paas, 2009). In general, it is possible that eye tracking methodology can contribute to computer-mediated instruction by using different design interventions to investigate processing of animations, videos, and other multimedia/multi-representation displays (Hyönä, 2010; Scheiter & van Gog, 2009; van Gog & Scheiter, 2010).

So far, a few studies have used eye tracking methodology to measure attention guidance, display design comprehension, and perceptual processing in learning from a complex animation in a computer-mediated environment (Boucheix & Lowe, 2010; de Koning et al., 2010; K. Meyer et al., 2010; Schmidt-Weigand et al., 2010). Boucheix and Lowe (2010) used eye tracking to investigate learners' online processing as they extracted information from an animated presentation. In the first experiment, Boucheix and Lowe (2010) compared the effect of three cueing conditions (i.e., arrow cue, spreading-color cue, non-cued). Boucheix and Lowe (2010) expected that eye tracking would reveal different patterns of attention in the different cueing conditions. The results of the eye tracking data did not find a difference between the cueing conditions (arrow cue and spreading-color cue), but did find that both of the cueing conditions had a larger number of fixations compared to the non-cued condition (Boucheix & Lowe, 2010).

In the second experiment, Boucheix and Lowe (2010) investigated the effect of synchronization versions (i.e., synchronized and non-synchronized) of a cued piano animation. Similar to the first study, the researchers used two types of cues: arrows and spreading-color. Their hypothesis was that the synchronized cueing version of the

spreading-color cues would direct the attention of the learners to more relevant components of the animation and therefore be more efficient for comprehension (Boucheix & Lowe, 2010). The results of the eye tracking data combined with comprehension data indicated that synchronization of cues is crucial to learners because it helps them coordinate important aspects of the visual exploration of the animated presentation (Boucheix & Lowe, 2010). They also found that spreading-color cuing can support learners in processing of complex animations, more than an arrow cue (Boucheix & Lowe, 2010).

In complex animations, learners are challenged to extract relevant information from a visual display. Measures of eye tracking allow researchers to make inferences about what information is attended to and how the information is interpreted by the learners (de Koning et al., 2010). de Koning et al. (2010) used eye tracking to examine how spotlight cuing influenced perceptual and cognitive processing when learning from complex animation. In this experiment, learners viewed an animation of the cardiovascular system with or without a spotlight-cue on the valves of the heart. As expected, learners looked more often and for longer periods of time at cued than non-cued content (de Koning et al., 2010). The difference in fixation pattern between the cued and non-cued condition was taken as evidence that cueing guides learners' attention to specific areas of the complex animation (de Koning et al., 2010).

One of the studies that applied eye tracking to investigate display design comprehension was conducted by Schmidt-Weigand et al. (2010). In this investigation, (Schmidt-Weigand et al., 2010) focused on the behavior associated with split attention in multimedia instructions. Specifically, the experiments examined how learners managed

split attention between text and visualizations as well as how text modality (i.e., written and spoken) affected the viewing behavior in a system-paced instruction (Schmidt-Weigand et al., 2010). The global eye movement patterns revealed that the learners spent more time reading than inspecting the visualizations. However, when the text was spoken the learners spent much more time inspecting the visualization (Schmidt-Weigand et al., 2010).

The second experiment conducted by Schmidt-Weigand et al. (2010) aimed at examining similar variables as the first experiment; however, in this experiment learners used a self-paced instructional environment. The results were comparable to the first experiment in that learners in the text group spent more time reading than inspecting the visualizations and the learners in the spoken text group spent more time inspecting the visualizations (Schmidt-Weigand et al., 2010). The fact that the learners could control the pace of the instruction did not change the way the learners interacted with the written and spoken text modality presentations. In this investigation, the use of eye tracking helped clarify concerns regarding the occurrence of the split attention effect in either a system-paced or self-paced instruction (Schmidt-Weigand et al., 2010).

The previous studies are relevant to this study because they focused on eye tracking methodology in computer-mediated instruction to measure attention guidance and display design comprehension. But, as mentioned earlier, eye tracking methodology has also been used in computer-mediated environments for perceptual processing (K. Meyer et al., 2010). In particular, it has been employed in perceptual processing when learning from an animation with different presentation speeds (K. Meyer et al., 2010). One problem that tends to occur in learning with animations is that some processes

depicted may be difficult to perceive due to the speed of the animation's presentation, which can be too slow or too fast for changes to be detected (van Gog & Scheiter, 2010).

K. Meyer et al. (2010) conducted experiments with eye tracking methodology to investigate the effect of high and low presentation speed of animation, in which they hypothesized that a high speed of presentation would emphasize macro-events, whereas a low speed was more likely to emphasize micro-events. In this study, a macro-event is made up of multiple micro-events (K. Meyer et al., 2010). The findings of the eye tracking data did not support the hypothesis. Fixation times did not differ between micro- and macro- events as a function of the presentation speed. Instead, the analysis of the learners' eye movements suggests they prefer to focus on micro-events even at a high presentation speed.

In addition to multimedia presentations in computer-mediated environments, eye tracking methodology has been used to address issues with learning from multi-representational sources (Scheiter & van Gog, 2009; Schwonke et al., 2009). Eye tracking has become a widely used approach to gain information on fixation location, fixation duration, and gaze duration of visual attention when learners are engaged in complex tasks. Therefore, eye tracking can shed light on how learners' use multiple representations during learning. Schwonke et al. (2009) conducted two experiments on learning with multi-representations in the domain of mathematics, in which eye tracking was used to obtain data concerning learners' interactions with those representations.

In the first experiment, the focus was on the allocation of visual attention to the different external representations and the relation between visual attention and learning (Schwonke et al., 2009). The learning environment for this study was a computer-based

instructional content with 15 static slides on probability theory and eight worked examples that included text, a tree diagram, and an equation (Schwonke et al., 2009). The results of this study revealed that more extensive visual processing of the diagrams in the worked examples was related to a better conceptual understanding of probability theory. Additionally, eye-tracking data revealed that no representation had been neglected. These results were based on the relative amount of time that learners spent looking at the different representations for each worked example. Furthermore, frequent transitions between diagrams and equations indicate that learners did not process the representations in isolation.

In the second experiment, Schwonke et al. (2009) used the same computer-based instructional content as in the first experiment. However, the learners in the experimental condition received a brief instruction on the functions of the tree diagrams in the worked examples (Schwonke et al., 2009). The goal was to test whether informing learners about the function of the tree diagram would alter the allocation of visual attention paid to the different representations and foster learning from multiple representations (Schwonke et al., 2009). This experiment established important conclusions about multi-representations in computer-mediated instruction. First, eye tracking data determined that simply informing students about the functions of representations in multi-representational learning materials has a remarkable positive effect on how fast or how much attention is devoted to a certain task aspects or whether task aspects are ignored (Scheiter & van Gog, 2009; Schwonke et al., 2009).

In all of the previously mentioned studies on eye tracking methodology in computer-mediated instruction, the primary eye movement measures were fixation time,

fixation order, and total fixations on pre-specified areas of interest (Boucheix & Lowe, 2010; de Koning et al., 2010; K. Meyer et al., 2010; Schmidt-Weigand et al., 2010; Schwonke et al., 2009). Additionally, researchers incorporated other useful and informative offline measures to complement the global research picture (Boucheix & Lowe, 2010; de Koning et al., 2010; K. Meyer et al., 2010; Schmidt-Weigand et al., 2010; Schwonke et al., 2009). These offline measures helped the researchers establish a connection between the eye movement measure and the performance/learning measure (Mayer, 2010). In eye tracking research, significant interpretation is required of the researcher to make sense of why an individual looks at an object for a certain amount of time and in a specific order (Scheiter & van Gog, 2009). Therefore, it is important to consider methodological triangulation, in which multiple data sources are analyzed in order to increase the validity of the results (Scheiter & van Gog, 2009). Eye movement is a very promising measure of an individual's visual attention, but it is important for researchers to note that eye movement is not self-explaining (Scheiter & van Gog, 2009).

Overall, in these studies eye-tracking methodology provided valuable data that allowed substantiated assumptions concerning underlying cognitive processes (Hyönä, 2010; Scheiter & van Gog, 2009; van Gog & Scheiter, 2010). Eye tracking also served as a research tool that enabled collection of unique and detailed data about how informational and instructional materials are processed (Hyönä, 2010; Scheiter & van Gog, 2009; van Gog & Scheiter, 2010).

Animated Agents' Research using Visual Attention Measures

In recent years researchers have also applied eye tracking methodology to the use of animated agents in interactive learning environments (Louwerse et al., 2009; Scheiter

& van Gog, 2009). An important and unresolved question that arose from contradictory research findings concerning the effectiveness of animated agents is whether the agent draws attention and cognitive resources away from other important information sources on the screen or whether it helps learners process information (Louwerse et al., 2009; Scheiter & van Gog, 2009). Studies regarding animated agents in computer-mediated instruction that incorporate eye tracking methodology can help empirically substantiate theories of human-computer interactions (i.e., the media equation) that assume that humans are inclined to treat computers (i.e., animated agents) as social partners when interacting with them (Reeves & Nass, 1996) and that have been recently applied to computer-mediated instruction (Scheiter & van Gog, 2009).

Thus far, one study has investigated how the presence of an educational animated agent in a computer-mediated environment affected the learners' visual attention (Louwerse et al., 2009). In a two experiment study, Louwerse et al. (2009) conducted an in-depth analysis of humans' perceptions, attention, and interactions with the agents. In the first experiment, Louwerse et al. (2009) measured fixation times with an eye tracking methodology on the four information sources of the Auto Tutor tutoring system interface (Louwerse et al., 2009). The four information sources were displayed in four different regions of the screen: the animated agent, the deep reasoning question, the student contributions, and the graphic display.

The analysis of total fixation time on the four information sources of the interface revealed that throughout the tutoring session the distribution of attentional resources did not vary over time (Louwerse et al., 2009). Although graphic displays were presented on the screen, the user's distributed their attention between the animated agent and the

displays (Louwerse et al., 2009). In fact, fixation analysis of six areas of the animated agent (i.e., eyes, nose, mouth, forehead, both cheeks, and shoulders) revealed that primarily fixations took place on the nose and eye areas (Louwerse et al., 2009).

In the second experiment, Louwerse et al. (2009) used the iSTART tutoring system, a multi-agent interface, and eye tracking to analyze the number of times a participant looked at an animated pedagogical agent when it was relevant for the conversation. Louwerse et al. (2009) hypothesized that if humans interact with animated agents as they would with other humans, they would fixate on an agent only while the agent was speaking. The findings of the study supported the hypothesis. The learners focused on the animated agent when the agent was speaking just as they would with humans (Louwerse et al., 2009). Additionally, eye tracking data revealed that the attention pattern did not wane over time (Louwerse et al., 2009). It continued throughout the interaction.

The results of the two experiments are very encouraging for research on animated agents in computer-mediated environments. Eye-tracking data demonstrated that learners respond to animated agents in ways that resemble response patterns found in human communication (Louwerse et al., 2009; Scheiter & van Gog, 2009). These results also suggest that animated agents in computer-mediated instruction do not distract the learners' attention away from relevant information. However, in order to further explore the topic and corroborate the findings other studies with similar eye tracking methodology, offline measures are needed. Such research would provide clarity to the role of animated agents in computer-mediated environments.

Overall, research with animated agents using eye tracking can provide unique information about what is visually attended to, in what order, and for how long (van Gog & Scheiter, 2010). It is believed that eye tracking data may enhance computer-mediated instruction by significantly improving their design based on knowledge of how learners process certain materials (Hyönä, 2010; Mayer, 2010; van Gog & Scheiter, 2010).

Effect of Emotion on Visual Attention

An increasing number of studies have addressed the influence of emotional stimuli in the modulation of visual attentional processes (Bonifacci, Ricciardelli, Lugli, & Pellicano, 2008; M. G. Calvo & Nummenmaa, 2008; M. G. Calvo, Nummenmaa, & Avero, 2008; M. G. Calvo, Nummenmaa, & Hyönä, 2007; Christianson, Loftus, Hoffman, & Loftus, 1991; Huijding, Mayer, Koster, & Muris, 2011; Hunt, 2007; Schmid, Schmid Mast, Bombari, Mast, & Lobmaier, 2011; Scott, O'Donnell, & Sereno, 2012; Shields, Engelhardt, & Ietswaart, 2012; Van der Stigchel, Imants, & Richard Ridderinkhof, 2011). Overall, voluntary visual attention enables selection of specific types of information (M. G. Calvo & Nummenmaa, 2008; Hunt, 2007). However, visual attention might also be directed to certain kinds of events, even when they are irrelevant, because of intrinsic meaning or salience (Hunt, 2007). Due to their adaptive relevance, emotional stimuli are expected to be detected quickly (M. G. Calvo et al., 2007).

Research on the preferential visual processing of emotional scenes competing for attention resources with neutral scenes revealed that there was preferential processing of emotional scenes (M. G. Calvo et al., 2007). Similar conclusions were reached by Christianson et al. (1991). In their investigation of emotional events, Christianson et al. (1991) discovered that participants pay higher visual attention to the central details of an

emotional event compared to neutral events. In fact, the central details were better retained by participants in the emotional condition (Christianson et al., 1991). Even in language processing, emotional words were compared to neutral words to investigate the effects of reading emotional words within a natural context (Scott et al., 2012). The results demonstrated significant visual attention effects of emotional words (Scott et al., 2012).

In everyday social exchanges, the faces and bodies of people around us are encountered together (Shields et al., 2012). However, emotion-recognition research has been dominated by the idea that facial expressions are the main source of identifying and interpreting emotional states in another person (Bonifacci et al., 2008; M. G. Calvo et al., 2008; M. Green, Williams, & Davidson, 2003; Schmid et al., 2011; Shields et al., 2012). Therefore, the majority of research on visual attention emotion recognition has focused on the face (Bonifacci et al., 2008; M. G. Calvo & Nummenmaa, 2008; M. G. Calvo et al., 2008; M. L. D. Green, 2003; Hunt, 2007; Schmid et al., 2011; Shields et al., 2012). Neurophysiological research has found that emotional information from faces is detected rapidly, 100 ms after stimulus onset, and different facial expressions are discriminated within an additional 100 ms (M. G. Calvo & Nummenmaa, 2008; M. G. Calvo et al., 2008).

Some research on visual attention and facial expression of emotion has been conducted to investigate whether visual attention is attracted or held by negative emotional faces (Hunt, 2007). The results showed that angry faces did not have any special status orienting visual attention (Hunt, 2007). Hunt (2007) interpreted this as evidence that negative emotional stimuli have a reflexive visual attention priority relative

to positive stimuli (Hunt, 2007). In fact, M. G. Calvo and Nummenmaa (2008) and M. G. Calvo et al. (2008) conducted a series of studies to investigate if some facial expressions of emotion are detected faster than others. The results of their experiments revealed that happy faces, followed by surprised and disgusted faces were detected faster than fearful, angry, and sad faces (M. G. Calvo & Nummenmaa, 2008; M. G. Calvo et al., 2008). These results confirmed that the so-called angry-face advantage might be restricted to a small subset of real faces or to prototypes of schematic facial stimuli, which might not be representative of the natural variance in expression of anger (M. G. Calvo et al., 2008).

Other results from research on visual attention and emotional faces indicates that participants generally focus on the feature areas of the face (i.e., eyes, nose, mouth) to a greater extent than non-feature areas (M. Green et al., 2003). Also, the mouth made a strong contribution to visual search for most expression, especially the happy expression (M. G. Calvo & Nummenmaa, 2008). The eye, on the other hand, played a minor role for expressions such as surprise, disgusted, and fear (M. G. Calvo & Nummenmaa, 2008). Lastly, research on visual attention and facial expression of emotion indicate that females recognize emotions on faces more accurately than males (Schmid et al., 2011).

Thus far, one study has investigated how people process information from faces and bodies (Shields et al., 2012). Shields et al. (2012) conducted a study using eye tracking to examine how information from the face and the body are processed when assessing emotional states. Eye movement showed that there were more fixations to the face and fewer fixations to the body, suggesting that participants focus greater extent on the face than on the body (Shields et al., 2012). These findings are consistent with the

notion that when decoding emotional expressions via visual attention, successful identification is typically based on the face.

In summary, eye tracking is sometimes referred to as “technology in search of an application” (Duchowski, 2003). Through the presentation of empirical research in this section of the chapter, it appears that there are many opportunities for interesting, meaningful research using eye tracking methodology. Although the design of supporting methodologies for eye tracking studies may pose some challenges, technological developments (i.e. equipment is more affordable and improved software to gather and analyze data) are making eye tracking more accessible (Duchowski, 2003).

Affective Detection and Emotional Responses

Although research in the area of emotion stretches back to the 19th century, the injection of affect into computer technologies is fairly recent (R. A. Calvo & D'Mello, 2010). The landmark book “Affective Computing,” authored by Picard (1997) prompted a wave of interest among computer scientists and engineers looking for ways to improve human-computer interfaces by coordinating emotions and cognition with task constraints and demands. In her book, Picard (1997) described three types of affective computing applications: systems that detect the emotions of the user, systems that express what a human would “feel” and systems that actually “feel” an emotion. The last decade has witnessed astounding research along all three fronts (R. A. Calvo & D'Mello, 2010). This dissertation addresses a system that expresses what a human would feel; however, it also focuses on a system that detects the emotions of the user.

Affect detection is critical because an affect-sensitive interface can never respond to users’ affective states if it cannot sense it (R. A. Calvo & D'Mello, 2010). An

important functionality of affect-sensitive interfaces is the capacity to perceive and understand the user's cognitive appraisals, action tendencies, and social intentions that are usually associated with emotional experiences (Valstar, Mehu, Bihan, Pantic, & Scherer, 2012; Zeng, Pantic, Roisman, & Huang, 2009). Overall, the goal of affective interfaces is to help users achieve a more natural interaction with devices (Bernhaupt, Boldt, Mirlacher, Wilfinger, & Tscheligi, 2007).

A change in the user's affective state is a fundamental component of human-human communication (Zeng et al., 2009). Some affective states motivate human actions, and others enrich the meaning of human communication (Zeng et al., 2009). Consequently, the traditional human-computer interaction, which ignores the user's affective states, filters out a large portion of the information available in the interaction process (Zeng et al., 2009). The more the interaction between human and machine becomes similar to the communication between humans the easier it gets to use (Bernhaupt et al., 2007).

Because facial behavior is believed to be an important source of such emotional and interpersonal information, automatic analysis of facial expressions is crucial to human-computer interaction (Valstar et al., 2012). Inspired by the "emotion as facial expressions" view and informed by considerable research that identifies the facial correlate of emotion, affective computing systems that use facial expressions for affect detection are increasingly common (R. A. Calvo & D'Mello, 2010; Valstar et al., 2012; Zeng et al., 2009). In this research a facial expression coding system, the FaceReader, is used for affect detection of the emotional responses of the participants towards the emotionally expressive animated agents presented in the computer-based simulation.

Research using the Facial Expression Coding System

Several research studies have used the FaceReader system as a reliable measurement tool (Aguiar, Vieira, Galy, Mercantini, & Santoni, 2011; Bernhaupt et al., 2007; Chentsova-Dutton & Tsai, 2010; Choliz & Fernandez-Abascal, 2012; Goldberg, 2012; Gorbunov, Barakova, Ahn, & Rauterberg, 2012; Grootjen, Neerincx, Weert, & Truong, 2007; Harley, Bouchet, & Azevedo, 2012; Smets, Neerincx, & Looije, 2012; Terzis, Moridis, & Economides, 2010, 2012; Zaman & Shrimpton-Smith, 2006). For user experience research, in particular, the FaceReader has been used extensively. For example, Goldberg (2012) used the automated facial analysis provided by the FaceReader as a measure of emotional valence to understand visual complexity of a web page. The FaceReader was also used by Zaman and Shrimpton-Smith (2006) to measure satisfaction, emotions, and “fun of use” as users completed tasks using a personal computer.

In real life settings, the FaceReader has been used to measure the emotional state of rescuers performing urban search and rescue (USAR) missions using a ground robot (Smets et al., 2012) or to detect the effects of isolation on the emotional states of crew members in long-term missions such as the Mars-500 (Gorbunov et al., 2012). Another real world task in which the FaceReader has been used for user experience research was the experiment conducted by Grootjen et al. (2007). In this experiment, Grootjen et al. (2007) measured facial expressions from the faces of team members in an Air Defense and Control Frigate during sailing sessions on board a Royal Netherland Navy ship (Gorbunov et al., 2012).

In psychology research, a few studies have integrated the FaceReader in investigations regarding human behavior (Aguiar et al., 2011; Chentsova-Dutton & Tsai, 2010). Aguiar et al. (2011) used the FaceReader as a measure of motor expression while studying human reactions to emotional episodes of an individual performing situations and contexts that led to error. Similarly, Chentsova-Dutton and Tsai (2010) used the FaceReader to measure emotional reactivity. Specifically, Chentsova-Dutton and Tsai (2010) measured the emotional reactivity of European American and Asian American adults towards negative emotions using sad and disgust film clips. The FaceReader was also incorporated in psychology research as a tool to validate the materials presented to the research participants (Choliz & Fernandez-Abascal, 2012). In their investigation, Choliz and Fernandez-Abascal (2012) used the FaceReader to assess pictures of faces portraying five basic emotions. These pictures were later presented to participants for recognition of emotional facial expressions.

In addition to user experience and psychology research, the FaceReader has also been used as a gaming development tool and for the measurement of emotional states in gaming research (Bernhaupt et al., 2007). Bernhaupt et al. (2007) incorporated the FaceReader to create an emotional interface that was controlled by the emotional facial expressions of the user (capture by the FaceReader) in the “Emotional Flowers” game. The game itself consisted of a flower that would grow or shrink depending on the measured emotions in the facial expressions (Bernhaupt et al., 2007). The intent was to influence the emotional states of the participants.

Animated Agent Research using a Facial Expression Coding System

Few researchers have investigated affect recognition associated with learning outcomes (Terzis et al., 2010). Recently, one study was conducted using facial expressions as a measurement of learners' emotion while performing computer-based assessment (Terzis et al., 2012). In this investigation, Terzis et al. (2012) used the facial expressions of emotions, collected using the FaceReader, as input for the emotional feedback provided by an embodied conversational agent in a tutoring system. The embodied conversational agent employed empathetic behaviors to regulate the student's emotional states (Terzis et al., 2012). The integration of the facial expression readings was similar to the game development mechanism used by Bernhaupt et al. (2007) in his game "Emotional Flowers." However, in this investigation Terzis et al. (2012) used emotion data to enhance the learners' experience in a computer-based instructional environment.

Harley et al. (2012) also conducted a study using the FaceReader to collect facial expression of emotions from learners during an instructional intervention. The purpose of this investigation was to examine the occurrence of co-occurring emotions while learners interacted with a pedagogical agent in the MetaTutor Intelligent Tutoring System (Harley et al., 2012). The facial expression data from the FaceReader suggested that co-occurring emotions represent a sizable portion of the emotional states experience by the learners (Harley et al., 2012). Another important finding from this investigation is that learners experienced a significant amount of sad emotions while interacting with the pedagogical agent in the MetaTutor environment (Harley et al., 2012).

The two investigations presented in this section refer to the use of the FaceReader in instructional and learning environments. These investigations Harley et al. (2012) and Terzis et al. (2012) represent the first exploration of a complex but important addition to the measurement of psychological process that learners experience in the instructional and learning process. In the future, facial affect processing could lead to expanded instructional interfaces with emotional communication and, in turn, more flexible, adaptable, and natural interaction between the learner and the elements of the instructional interface (Uyl & Kuilenburg, 2005).

Learner Expertise

Since its timid beginnings in the 1940s, the concept of learner expertise has been explored extensively as one of the most powerful tools for performance improvements (Germain, 2011). The first wave of research on expertise started with the increased interest in computer science and artificial intelligence, in which researchers focused on information processing and decision-making processes (Ericsson & Charness, 1994; Germain, 2011; Shanteau, 1992). The findings from these studies influence the work of researchers on expertise, who developed expertise theories that describe heuristic processes applicable to almost all domains (Germain, 2011; Shanteau, 1992). The second wave of research on expertise, from which most of the well-known fundamentals of expertise originated, focused on problem-solving, memory, and speed wave (Germain, 2011; Shanteau, 1992). This second wave started in the late 1980s (Germain, 2011). Lastly, the third wave of research in expertise, which started in the 1990s, focused on the relationship between emotional intelligence and expertise (Germain, 2011). It was influenced by the connectionism theory. This theory refers to the ability to create

cognitive networks and to connect small bits of information in a meaningful way (Germain, 2011).

Due to its potential to increase performance in organizations, the past 20 years have seen an increase in the pace of expertise research (Ericsson & Charness, 1994; Ericsson, Krampe, & Tesch-Römer, 1993; Ericsson & Lehmann, 1996; Germain, 2011; Haerem & Rau, 2007; Kalyuga, Rikers, & Paas, 2012; Moxley, Ericsson, Charness, & Krampe, 2012; Shanteau, 1992; Vicente & Wang, 1998). This increased interest in expert performance and the ways it can be developed has led to the creation of many views and definitions of experts (Germain, 2011). In fact, there are almost as many definitions of “expert” as there are researchers investigating this topic (Shanteau, 1992). From a general perspective, Shanteau (1992) defined experts as those “who have been recognized in their profession as having the necessary skills and abilities to perform at the highest level.” In contrast to experts, novices are beginners in both skill and knowledge. They have years of studies and may work at sub-expert levels; however, they lack the ability to function as skilled decision makers (Shanteau, 1992).

Several themes emerge from the expertise body of research. First, expertise is domain specific (Ericsson & Charness, 1994; Shanteau, 1992). In virtually all domains, insights and knowledge are steadily accumulating and undergo continuous change (Ericsson & Charness, 1994; Ericsson et al., 1993). To reach the status of an expert, an individual must master the existing knowledge and techniques in a specific domain (Ericsson & Charness, 1994; Ericsson et al., 1993; Ericsson & Lehmann, 1996). According to some researchers, experts reach their maturation points after a decade or more of extensive deliberate practice (Ericsson et al., 1993; Ericsson & Lehmann, 1996).

According to this rule, not even the most talented individual can attain a significant level of performance without approximately 10 years of preparation (Ericsson et al., 1993; Ericsson & Lehmann, 1996).

Second, expertise is acquired through stages of development (Ericsson & Charness, 1994; Ericsson et al., 1993; Ericsson & Lehmann, 1996; Shanteau, 1992). Extensive research calls into question whether experts are born or made through extensive practice and experience (Ericsson & Charness, 1994; Ericsson et al., 1993; Germain, 2011). Sir Francis Galton, one of the first scientists to investigate the topic of expertise, argued that expertise was a consequence of inherited natural ability (Ericsson & Charness, 1994; Ericsson et al., 1993). In other words, Galton believed that expertise was passed on from parents to their off spring (Ericsson et al., 1993). However, the domain specific nature of superior performance implies that acquired knowledge and skill are required to attain expert performance (Ericsson et al., 1993). Additionally, broad research on expertise was able to confirm that experts performed deliberate practice in order to reach elite performance levels (Ericsson & Charness, 1994; Ericsson et al., 1993; Ericsson & Lehmann, 1996). This term, deliberate practice, refers to individualized training activities especially designed by a coach or teacher to improve specific aspects of an individual's performance through repetition and successive refinement (Ericsson & Charness, 1994; Ericsson et al., 1993; Ericsson & Lehmann, 1996).

Third, experts use different thinking strategies (Ericsson & Charness, 1994; Shanteau, 1992). When referring to the thinking strategies that experts use, research has demonstrated that experts use forward reasoning (Ericsson & Charness, 1994). In other words, as experts read the description of the problem situation; an integrated

representation is generated and updated (Ericsson & Charness, 1994). Therefore, when the expert finally encounters the question in a problem, they simply retrieve a solution plan from memory (Ericsson & Charness, 1994). This ability to create internal representation of the relevant information about the situation is critical to their ability to reason, to plan out, and to evaluate consequences of possible actions (Ericsson & Charness, 1994). These representations are used to cue the expert's knowledge whereas novices do not have this kind of orderly and efficient access to their knowledge (Ericsson & Charness, 1994).

Fourth, the thinking of experts is more automated (Ericsson & Charness, 1994; Ericsson & Lehmann, 1996; Shanteau, 1992; Vicente & Wang, 1998). The automated thinking processes of experts can be credited to their acquired memory skill, which allows experts to have superior memory (Ericsson & Charness, 1994; Ericsson & Lehmann, 1996; Vicente & Wang, 1998). Research has shown that the working memory of experts are essentially unaffected by interruptions (Ericsson & Charness, 1994; Ericsson & Lehmann, 1996; Vicente & Wang, 1998). For example, when experts are forced to engage in an unrelated activity designed to eliminate storage of information in their working memory they are able to resume activity without decrement of performance (Ericsson & Charness, 1994; Ericsson & Lehmann, 1996; Vicente & Wang, 1998). Additionally, there are critical aspects on how experts store and index information in their long-term memory (Ericsson & Charness, 1994; Ericsson & Lehmann, 1996; Vicente & Wang, 1998). Overall, experts build memory skill to meet the demands of encoding and accessibility in their expertise domain (Ericsson & Charness, 1994; Ericsson & Lehmann, 1996; Vicente & Wang, 1998).

Although several themes have already been established regarding expert performance, there are still unanswered questions that, if answered, could help better explain the nature of expertise. Studies in expertise performance could allow novices to improve their ability to capture and transfer knowledge (Haerem & Rau, 2007). In fact, novices could potentially benefit from using rules and problem-solving strategies used by experts (Haerem & Rau, 2007). From an instructional design perspective, understanding the nature of expertise is highly relevant for understanding learning processes and the design of effective learning environments (Kalyuga et al., 2012). For instructional designers, uncovering the processes that underlie experts' performance is necessary to design and develop instructional methods and content that allow novices to improve their own performance (Kalyuga et al., 2012).

Research on expertise in recent years has focused on several important topics, such as task perception differences and the role of intuition and deliberate thinking (Haerem & Rau, 2007; Moxley et al., 2012). Haerem and Rau (2007) were able to establish that the degree of expertise differs in its influence on perceptions of task analyzability, variability, and performance. From a research perspective, the results from the research conducted by (Haerem & Rau, 2007) are relevant to this study because they suggest that individuals with different levels of expertise may literally see the same task differently. Equally interesting were the findings by Moxley et al. (2012) who demonstrated that in controlled environments experts benefit as much from deliberation to solve difficult problems as novice tournament players. However, for easy problems a reduced benefit for continued deliberation is seen for experts (Moxley et al., 2012).

Another important topic in the literature regarding experts and expert performance is the implications of the expertise reversal effect (Kalyuga, 2007; Kalyuga & Renkl, 2010; Kalyuga et al., 2012). This research demonstrates that more experienced students may not learn as well as expected from instruction that are very effective for novices (Blayney, Kalyuga, & Sweller, 2010; Homer & Plass, 2010; Kalyuga, 2007; Kalyuga & Renkl, 2010; Kalyuga et al., 2012; Nückles, Hübner, Dümer, & Renkl, 2010; Oksa, Kalyuga, & Chandler, 2010; Salden, Aleven, Schwonke, & Renkl, 2010). In an instructional setting, lecturers and trainers assume that if some instructional material is effective for novice learners, it should also work with more experience learners (Kalyuga et al., 2012). However, empirical research has shown that processing instruction intended for novices could be redundant for experts and as a result consume more of their cognitive resources (Blayney et al., 2010; Homer & Plass, 2010; Kalyuga, 2007; Kalyuga & Renkl, 2010; Kalyuga et al., 2012; Nückles et al., 2010; Oksa et al., 2010; Salden et al., 2010). On one hand, well-guided instruction that is optimal for novices may hinder performance of more experienced learners by distracting them from executing already learned procedures (Kalyuga et al., 2012). On the other hand, minimally guided instruction optimal for experts would require novices to search for suitable information, which will ultimately consume their cognitive resources (Kalyuga et al., 2012).

In medical expertise, however, the relationship between performance and expertise level is not always straight forward (Kalyuga et al., 2012). In fact, medical experts do not always outperform individuals with less experience (Kalyuga et al., 2012). For medical expertise, the intermediate effect in clinical case studies plays a prominent role (Kalyuga et al., 2012). According to the intermediate effect, experienced medical

personnel outperform advance medical students on diagnostic performance (Kalyuga et al., 2012). However, medical students are better at remembering and describing signs and symptoms of patients (Kalyuga et al., 2012). The possible explanation of this intermediate effect can be explained by the notion of knowledge encapsulation. The knowledge encapsulation notion states that experts immediately recognize the patterns of signs and symptoms to arrive at a diagnostic conclusion, without referring to their medical knowledge (Kalyuga et al., 2012). The knowledge of medical experts has become integrated and riveted as a result of many years of clinical practice; therefore it plays a less prominent role when dealing with a patient diagnosis (Kalyuga et al., 2012). Students, on the other hand, lack the clinical experience and have to engage in detail biomedical reasoning in order to link the signs and symptoms to reach the correct diagnosis (Kalyuga et al., 2012).

Learner Expertise and Visual Attention

Another important theme with regard to experts is how their visual attention allocation differs from novices in tasks that involve complex and dynamic visual stimuli. So far, several studies have addressed the issue of how experts perceive and interpret visual stimuli using eye tracking (Gegenfurtner, Lehtinen, & Säljö, 2011; Jarodzka, Scheiter, Gerjets, & van Gog, 2010; Kostons et al., 2009). Eye tracking has provided interesting insights into how experts differ from novices using simple basic indicators (i.e. number of fixations and duration of fixations) when processing tasks with a high visual component. These studies applied eye tracking in a range of professional settings, including aviation, arts, and sports (Gegenfurtner et al., 2011).

There are three theories that explain how expertise influences the comprehension of visualization. The first one is the theory of long-term working memory, which focuses on qualitative changes in memory structure (Gegenfurtner et al., 2011). This theory is fairly similar to the acquired memory skill notion (Ericsson & Charness, 1994; Ericsson & Lehmann, 1996; Vicente & Wang, 1998). The theory of long-term working memory assumes that experts have an extended capacity for information processing owing to the acquisition of retrieval structures that allow advanced learners to rapidly encode information in long-term memory and efficiently access it for later tasks (Gegenfurtner et al., 2011). Therefore, if eye movements reflect the processes underlying task performance and if experts encode and retrieve information more rapidly than novices, then an expert's rapid information processing should lead to shorter fixation duration.

The second theory that attempts to explain how different levels of expertise affect comprehension of visualization is the information-reduction theory (Gegenfurtner et al., 2011). This theory proposes that expertise optimize information processing by neglecting task-irrelevant information and actively focusing on task-relevant information, which is accomplished through strategic considerations to selectively allocate attentional resources. In other words, redundant information is perceptually ignored wherever possible (Gegenfurtner et al., 2011). For eye tracking, this theory suggests that experts should have fewer fixations of shorter duration on task-redundant areas and more fixations of longer duration on task-relevant areas (Gegenfurtner et al., 2011). The current study should corroborate this reasoning.

Lastly, the holistic model of image perception is the third theory that researchers have used to explain expertise in the comprehension of visualization (Gegenfurtner et al.,

2011). This theory focuses on extension of the visual span. This theory proposes that expertise changes the sequential organization of perceptual processes, allowing experts to proceed from an initial global analysis toward a finer-grained breakdown into hierarchical structural components (Gegenfurtner et al., 2011). This ability to have a holistic analysis should be reflected in longer saccade length and in shorter times to first fixate on task-relevant areas (Gegenfurtner et al., 2011).

These three theories address different aspects of expertise influence on the comprehension of visualization. They are not mutually exclusive (Gegenfurtner et al., 2011). These theories provide complementary accounts for some of the mechanisms underlying the reproducibility of expert behavior when comprehending domain-specific visualizations. Each of these theories can be generalized across a range of visualization tasks (Gegenfurtner et al., 2011). In addition to the previously mentioned theories, it is important to analyze how differences in expertise performance and eye movements may vary based on the characteristics of the visualization and the task (Gegenfurtner et al., 2011).

The gap between experts and novices can be reduced through the use of specific characteristics of visualizations that make them easier to analyze. First, the gap can be narrowed by reducing extraneous processing demands, as extraneous material can be detrimental to novices (Gegenfurtner et al., 2011). Additionally, the gap between experts and novices can be narrowed if the visualizations contain elements that foster the generative processing of essential material (Gegenfurtner et al., 2011). For example, visualizations should present related sources of information that could not be understood in isolation. Some learners show better comprehension when information is delivered

through both visual and verbal channels. While the first two characteristics reduce the gap between novices and experts by raising the performance of novices, the last characteristic reduces the gap by inducing an expertise reversal effect (Gegenfurtner et al., 2011). The expertise reversal effect can be induced when learners who have high prior knowledge or visuospatial ability are presented with visual stimuli with redundant information (Blayney et al., 2010; Homer & Plass, 2010; Kalyuga, 2007; Kalyuga & Renkl, 2010; Kalyuga et al., 2012). An example of this characteristic is when an expert that learns better through pictures is presented with a visualization that includes a combination of both pictures and text. Overall, these different characteristics of visualizations can moderate the gap in performance between experts and novices in a visual attention task.

Besides visualization characteristics, there are three other characteristics of visual attention tasks that researchers believe moderate the performance difference between experts and novices. The first characteristic is task complexity (Gegenfurtner et al., 2011). Tasks, in general, vary as a function of their contextual demands. Eye tracking research on the comprehension of visualizations recognizes four levels of task complexity: viewing tasks, detection tasks, decision tasks, and problem solving tasks (Gegenfurtner et al., 2011). Each task level has a different desired outcomes and path to attain the desired outcome. The difference in eye movements' patterns and performance between experts and novices will vary base on task complexity.

Time-on tasks, limited or unlimited, is another characteristic that can moderate performance between experts and novices on the comprehension of visualizations (Gegenfurtner et al., 2011). Evidence suggests that when time is unlimited experts tend to

spend less time-on tasks completion than novices; due to their superior speed in information processing (Gegenfurtner et al., 2011). It is expected that when time is limited, expertise difference between experts and novices will vary (Gegenfurtner et al., 2011). Finally, the third characteristic of a task that can moderate the performance between experts and novices is task control (Gegenfurtner et al., 2011). It is generally assumed that novices perform better when visualizations are user-paced rather than system-paced because user control allows the user to regulate visuospatial processing demands in the working memory (Gegenfurtner et al., 2011). In summary, differences between eye movement and performance between experts and novices will vary as a function of task complexity, time-on task, and task control.

A recent empirical investigation compared experts versus novices on performed visual attention tasks focused on interpretation of dynamic visual stimuli (Jarodzka et al., 2010). Jarodzka et al. (2010) conducted an investigation that aimed at identifying expertise effects in perceiving and interpreting complex, dynamic stimuli as a pre-requisite for designing effective instructional material in the domain of fish locomotion. This study investigated how different levels of expertise in biology would be reflected in differences in task performance as well as in different strategies (Jarodzka et al., 2010). The results of this investigation revealed that experts' more efficiently focus on relevant areas of dynamic visual stimuli compared to novices (Jarodzka et al., 2010). Additionally, experts did not primarily focus on features crucial to fish locomotion; instead, they concentrated on features that allowed them to identify the fish species (Jarodzka et al., 2010). This indicated that experts use a different strategy; they use knowledge-based shortcuts to activate the appropriate schema (Jarodzka et al., 2010).

Both the visualization and tasks characteristics theories and the empirical research presented in this section support the use of eye tracking methodology to analyze the differences in visual attention performance between experts and novices. Research on the analysis of eye movement differences may inform the design of learning environments to include viewing the scan paths of experts for directing the attentional resources of novices (Gegenfurtner et al., 2011).

Expertise Theory in Nursing

In nursing, the most influential theory on expertise was presented by Benner (2001). In this theory, Benner (2001) proposes that the road from novice to expert encompasses five stages. In the “novice” stage, beginners learn through instructions (Benner, 2001; Gobet & Chassy, 2008). They acquire domain specific facts, features and rules (Benner, 2001; Gobet & Chassy, 2008). After concrete experience within the domain, “novices” move to the “advanced beginner” stage. At the advance beginner stage, individuals start to use and make sense of situational elements (Benner, 2001; Gobet & Chassy, 2008). Attributes start to depend on the context (Benner, 2001; Gobet & Chassy, 2008). From “advanced beginners,” individuals transition to the “competence” stage. In the competence stage, individual organize their actions in terms of hierarchical long-range plans (Benner, 2001; Gobet & Chassy, 2008). During the competence stage there is an increased level of efficiency, although planning is still conscious, abstract, analytic, and deliberate (Benner, 2001; Gobet & Chassy, 2008).

From competent, individuals transition to the “proficiency” stage (Benner, 2001). In the proficiency stage, situations are perceived as a whole rather than as unconnected aspects (Benner, 2001; Gobet & Chassy, 2008). Proficient individuals can organize and

understand problem situations intuitively (Benner, 2001; Gobet & Chassy, 2008).

Proficient individuals still require analytical thinking to choose an action (Benner, 2001; Gobet & Chassy, 2008). Finally, in the “expertise” stage, understanding of a task as well as decision of what to do next is intuitive and fluid (Benner, 2001; Gobet & Chassy, 2008).

Benner (2001) emphasized the importance of being emotionally involved in the development of nursing intuition. While beginners’ emotions are characterized by anxiety, which impedes their practice, more advance nurses can rely on emotional responses which they use as information and guiding cues (Benner, 2001; Gobet & Chassy, 2008). These cues amplify the nurses’ perceptual awareness, but also shape their clinical know-how, ethical component, and emotional involvement with patients and their families (Benner, 2001; Gobet & Chassy, 2008).

Overall, Benner (2001) provides important insights on the complex interaction between nursing theory and practice. However, one major criticism of Benner (2001) is that research in developmental psychology empirically establishing the reality of stages is a difficult matter, requiring complex mathematics and a wealth of quantitative data, which are lacking in this case (Gobet & Chassy, 2008). A related point is that the very status of the individual during each stage is unclear. Benner (2001) implies that individuals can be categorized unequivocally in one stage. However, there is evidence that individuals can be fluent in one sub-field and perform with much less fluidly in another sub-field of the same domain (Gobet & Chassy, 2008). To summarize, Benner’s theory is too simple to account for the multifaceted pattern of phenomena linked to expertise in nursing (Gobet & Chassy, 2008).

More recently, Gobet and Chassy (2008) introduce the template theory (TempT) of expert intuition. A key assumption of the TempT theory is that experts are hampered by the same cognitive limits as novices. To improve to the point that they become experts, novices must learn a large number of perceptual patterns, known as chunks (Gobet & Chassy, 2008). Additionally, Gobet and Chassy (2008) state that expert intuition compromises five key features: rapid perception of pattern recognition, lack of awareness of the processes engaged, holistic understanding of the situation, decisions based on intuition are generally correct, and intuition colored by emotions. In general the TempT theory suggests a different approach compared to Benner (1984). Gobet and Chassy (2008) acknowledge the importance of understanding a patient as a whole but it also proposes that this whole is decomposable into parts and their relations. Therefore, in principle, instructional methods can be developed for teaching these components incrementally (Gobet & Chassy, 2008). Another implication of the TempT expertise theory is that human knowledge can be approximated as chunks and templates, and that instructional methods can be developed to foster the acquisition of these knowledge structures (Gobet & Chassy, 2008).

In conclusion, only through continued investigation of human expertise will we better understand the concept and use it to gauge human performance (Germain, 2011). Because expertise is often seen as being domain specific, researchers should expand to specific fields such as nursing expertise. There are many unanswered questions regarding experts in the nursing field. By capturing and examining the performance of experts in a given domain, researchers could identify domain specific skills that circumvent basic limits on memory processing and practice (Ericsson & Charness, 1994).

Pain Assessment and Management in Nursing

This review provides a synopsis of the literature on pain assessment and management practices in clinical settings, current nursing knowledge and attitudes towards pain, and the type of nursing curriculum and professional development used for pain management education. This literature informed the development of the computer-based simulation of pain assessment and management used for this dissertation.

Pain Assessment and Management

Pain is frequently an initial symptom among emergency department patients (Baharuddin, Mohamad, Abdul Rahman, Ahmad, & Nik Him, 2010; Bergman, 2012; Clarke et al., 1996; Downey & Zun, 2010; Hogan, 2005; MacLaren & Cohen, 2005; Paulson-Conger, Leske, Maidl, Hanson, & Dziadulewicz, 2011; Plaisance & Logan, 2006; Safdar et al., 2009; Shaban, Holzhauser, Gillespie, Huckson, & Bennetts, 2012; Simpson, Kautzman, & Dodd, 2002; Tanabe & Buschmann, 1999, 2000). In recent research studies, pain was found to be present in 60 to 90 percent of patients arriving at the emergency departments (Baharuddin et al., 2010; Bergman, 2012; Downey & Zun, 2010; Fry, Holdgate, Baird, Silk, & Ahern, 1999; Hogan, 2005; Tanabe & Buschmann, 2000; Thomas, 2007; Wilsey, Fishman, Ogden, Tsodikov, & Bertakis, 2008).

Researchers have defined pain as suffering, distress, soreness or an unpleasant sensation that results from physiological response to a variety of noxious mechanical, thermal, or chemical stimuli (Fry et al., 1999; Lindberg & Engström, 2011; Paulson-Conger et al., 2011; Polomano, Dunwoody, Krenzischek, & Rathmell, 2008).

Pain is considered the fifth vital sign, and therefore should be assessed at the same time as the temperature, pulse, respiration, and blood pressure (Baharuddin et al., 2010;

Garra et al., 2010; McCarberg & Stanos, 2008; Starck, Sherwood, & Adams-McNeill, 2000; Thomas, 2007). Most patients not only want pain relief but also want to know what is causing their pain (Hogan, 2005). The most common source of pain are chest pain, trauma, extremity fractures, migraine headaches, surgery, invasive procedures, and therapeutic devices (Binkowska-Bury, Januszewicz, Wolan, Sobolewski, & Mazur; Hogan, 2005; Paulson-Conger et al., 2011; Tse & Ho, 2012).

Patients have been found to be credible judges of their own pain (Starck et al., 2000; Vincent, Wilkie, & Szalacha, 2010). A patient's self-report is the most reliable indicator of the existence and intensity of pain in individuals able to verbally communicate (Alexander et al., 2005; Garra et al., 2010; Herr, 2010, 2011; Kamel, Phlavan, Malekgoudarzi, Gogel, & Morley, 2001; Paulson-Conger et al., 2011; Vincent et al., 2010; Ware, Epps, Herr, & Packard, 2006). Therefore, patient self-report is acceptable as the basis for planned intervention (Alexander et al., 2005; Starck et al., 2000). Pain assessment should cover pain intensity, location, and characteristics, as well as reporting of pain-related interference with the patient's activities (Carlson, 2009; Herr, 2010, 2011; McCarberg & Stanos, 2008; Starck et al., 2000; Tanabe & Buschmann, 1999). Evidence-based pain assessment practice provides the foundation for diagnosis and development of an effective treatment strategy for the patient (Carlson, 2009; Herr, 2010, 2011; McCarberg & Stanos, 2008). Pain often requires multiple pain-relief strategies such as repositioning, relaxation techniques, and/or pharmaceutical intervention before relief is achieved (Rutledge & Caple, 2011). Two additional factors in managing pain are the patient-nurse interaction and education of the patient-family throughout the treatment period (Herr, 2011; Starck et al., 2000).

Sensitivity to pain varies widely between patient populations (i.e., older adults, children, people of various cultural backgrounds, and patients with sensory alterations) (Czarnecki et al., 2011; Rutledge & Caple, 2011; Safdar et al., 2009). Pain can cause both immediate and long-term harmful effects that do not discriminate based on age, gender, race, ethnicity, or socioeconomic status (Czarnecki et al., 2011). Long-term effects of pain include insomnia, depression, changes in appetite, and fatigue (Brown, Kirkpatrick, Swanson, & McKenzie, 2011; Czarnecki et al., 2011; Duke, Haas, Yarbrough, & Northam, 2010; Herr, 2010, 2011; Kamel et al., 2001; McCarberg & Stanos, 2008; Paulson-Conger et al., 2011; Zhang et al., 2008). In older adults, pain syndromes are common. Yet, older adults are less likely than younger patients to have their pain effectively managed because of fear among medical professionals of drug to drug interactions and reluctance to prescribe opiates (Rutledge & Caple, 2011; Schofield, 2012). Children with pain can experience emotional difficulties, disruption in school attendance, and impaired social skills (MacLaren & Cohen, 2005; Rutledge & Caple, 2011). Additionally, depending on the cultural norms, patients of different ethnic groups will be more or less verbally expressive about their pain (Rutledge & Caple, 2011). Therefore, pain assessment requires monitoring for changes in behaviors (physical, emotional, cognitive), expression, and posture as well as listening for verbal cues (Czarnecki et al., 2011; Polomano et al., 2008; Rutledge & Caple, 2011).

Several researchers advocate the adoption of a single, appropriate, self-report, pain-rating scale (Carpenter & Brockopp, 1995; Herr, 2010, 2011; Starck et al., 2000). Currently, there are several reliable, valid pain assessment tools available for use with adult patients (Baharuddin et al., 2010; Paulson-Conger et al., 2011; Terai, Yukioka, &

Asada, 1998). The pain scale a clinician chooses should be based upon the patient's communication style, cognitive function, and verbal abilities (Herr, 2010; McCarberg & Stanos, 2008). One common pain scale is the visual analog scale (VAS), which is a simple and sensitive means of pain assessment that uses a series of facial expression to illustrate a spectrum of pain intensity along a sliding scale (Carpenter & Brockopp, 1995; Garra et al., 2010; Krulewitch et al., 2000; Lindberg & Engström, 2011; McCarberg & Stanos, 2008; Terai et al., 1998). The visual analog scale provides sensitive measures to discriminate between various analgesic treatments and changes in pain intensity (Garra et al., 2010; McCarberg & Stanos, 2008). The Faces Scales are also a simple, self-reporting method this is used mainly for children because it does not require verbal facility (Garra et al., 2010; McCarberg & Stanos, 2008; Terai et al., 1998). Faces Scales use a series of facial expressions to illustrate a spectrum of pain intensity (Garra et al., 2010). The faces scales are also used with populations for whom self-report is not possible and facial expression of pain is the primary means of communicating distress (Krulewitch et al., 2000; McCarberg & Stanos, 2008; Terai et al., 1998).

Although many pain scales are available for clinicians to use for the initial assessment of pain, the Short-Form McGill Pain Questionnaire (MPQ) and the PQRST mnemonic are the most commonly used to assess both the pain quality and severity (McCarberg & Stanos, 2008; Melzack, 1987). The Short-Form MPQ is divided into two sections. The first section is the Pain Rating Index. This section lists sensory and affective adjectives that describe the quality and severity of pain. The patient is instructed to place a check mark in the column that represents their degree of pain (McCarberg & Stanos, 2008; Melzack, 1987). The second section is the Present Pain Intensity that

contains a visual analog scale to help patients communicate the severity of their pain (McCarberg & Stanos, 2008; Melzack, 1987).

The PQRS mnemonic was originally proposed by the American Pain Society to help clinicians remember the elements of initial pain evaluation (McCarberg & Stanos, 2008). P stands for provocative, a point where pain triggers should be identified. Q stands for assessing the quality of pain. R stands for identifying the region of pain. S stands for rating the severity of pain. Lastly, T stands for temporal, the point at which the onset, course, and fluctuations of the pain should be assessed. These points are all elements of the initial evaluation that should be conducted during the first visit with a patient (McCarberg & Stanos, 2008).

Unfortunately, research shows that patients often receive inadequate, inappropriate, and untimely pain assessment and relief within emergency departments (Bergman, 2012; Carlson, 2009; Fry et al., 1999; Herr, 2011; Herr et al., 2004; Mezei & Murinson, 2011; Plaisance & Logan, 2006; Thomas, 2007). This is evidenced by research and literature on the topic as well as anecdotal experiences of those who have spent time in a hospital setting, whether as a patient, visitor, or member of a multidisciplinary team (Herr et al., 2004; Krulewitch et al., 2000; Plaisance & Logan, 2006; Thomas, 2007; Zalon, 1995). An inadequate pain assessment can result in appropriate treatment being withheld thereby negatively impacting health outcomes (Puntillo, Neighbor, O'Neil, & Nixon, 2003). Appropriate pain relief has been shown to be associated with better patient outcome, shorter lengths of stay, and reduced costs of care (Heye & Goddard, 1999; Simpson et al., 2002).

Knowledge and Attitudes towards Pain Assessment and Management in Nursing

To effectively manage emergency department patients' pain, an understanding of the basic principles of a pain assessment, actions of pharmacologic agents, and the effectiveness of non-pharmacologic interventions by nurses is essential (Baharuddin et al., 2010; Herr et al., 2004; Tanabe & Buschmann, 2000; Thomas, 2007). However, knowledge of pain management principles has been studied in both physicians and nurses, demonstrating an inadequate knowledge base (Clarke et al., 1996; Mezei & Murinson, 2011; Plaisance & Logan, 2006; Schofield, 2012; Shaban et al., 2012; Simpson et al., 2002; Tanabe & Buschmann, 2000; Zalon, 1995; Zhang et al., 2008). In other words, the importance of pain assessment and pain management often fails to be emphasized during health care professionals education (Fry et al., 1999).

Overall, research has identified lack of knowledge about pain management as the most important barrier to effective pain management (Clarke et al., 1996; Keyte & Richardson, 2011; Puntillo et al., 2003; Simpson et al., 2002; Tanabe & Buschmann, 2000; Zhang et al., 2008). Research conducted on the knowledge and attitudes of nurses demonstrates that 39 percent of nurses do not understand the differences between physical dependence, addiction, and tolerance (Brown et al., 2011; Clarke et al., 1996; Tanabe & Buschmann, 2000). In fact, only 28 percent of emergency nurses were able to correctly identify the percentage of patients who become addicted to opioids as less than 1 percent (Tanabe & Buschmann, 2000). This type of misunderstanding may lead to an overly cautious concern about addiction, causing nurses to under treat pain.

Another frequent knowledge gap found in recent research studies is an understanding of how to treat pain prior to diagnosis of the underlying condition (Tanabe

& Buschmann, 2000). For many years, surgeons have continued to believe that abdominal pain should not be treated before their evaluation (Tanabe & Buschmann, 2000). This long-standing myth has affected nursing practice, but has recently been challenged. In fact, recent research provides evidence that an accurate diagnosis is more likely after administering opioids because it can decrease the amount of guarding and allow nurses and physicians to conduct a more accurate physical examination (Tanabe & Buschmann, 2000). This finding is important because while it is the physician's job to diagnose the underlying condition causing the patient's pain, the nurse's role is to assist in the management of pain while the cause of the pain is being determined (Tanabe & Buschmann, 1999).

One of the major barriers to best practice in pain management is the misconception that patients exaggerate their pain (Simpson et al., 2002). Discouraging findings from several research studies show that the majority of nurses do not accept patient self-report as the most reliable indicator of pain (Carlson, 2009; Favaloro & Touzel, 1990; Herr, 2011; Herr et al., 2004; Simpson et al., 2002). Subjectivity of pain is a key concept in understanding pain from the patient's perspective (Tanabe & Buschmann, 1999). However, nurses like to rely on objective data such as laboratory results and EKG findings (Bergman, 2012; Tanabe & Buschmann, 1999). It is often difficult for nurses to accept the pain rating if the patient looks "fine." Tanabe and Buschmann (1999) discovered that the severity of pain rating by the patient did not influenced the treatment of pain. In practice, patients were equally as likely to receive an analgesic, regardless of the severity of their pain. By drawing attention to the patient's pain self-report and minimizing assumptions, the routine use of valid assessment methods

and tools by nurses may improve pain management practices (Baharuddin et al., 2010; Binkowska-Bury et al.; Carlson, 2009; Gordon, Greenfield, Marvin, Hester, & Lauterbach, 1998; Puntillo et al., 2003; Ware et al., 2006; Zhang et al., 2008).

Patient factors, including age, lifestyle, ethnicity, and gender often influence the nurse's assessment of pain and interventions provided to the patient (Carlson, 2009). In older adults, insufficient treatment and misdiagnosis frequently occur because of the assumptions made by health care providers that pain is a normal consequence of aging (Brown et al., 2011; Herr, 2010; Long, 2011; Schofield, 2012; Tse & Ho, 2012). Additionally, misconceptions about pain management leading to poor communication influence how older adults express their pain (Evans, 2004). Effective communication plays a key role in encouraging and enabling older patients to report pain, while ineffective communication hinders pain assessment and management (Evans, 2004; Herr, 2011). Nursing staff should be aware that elderly individuals often underreport their pain experiences because of a belief or fear that they will be perceived negatively by their health care provider (Brown et al., 2011; Kamel et al., 2001).

Due to the high prevalence of pain as a primary symptom, it is very important for nurses to have a clear understanding of the pain experience of the patient and the management strategies that can provide effective evidence-based approaches (Brown et al., 2011). This is a rapidly changing field, so nurses must stay abreast of new knowledge and treatment as researchers identify new pharmacologic and non-pharmacologic pain treatment strategies (Brown et al., 2011; Long, 2011).

Pain Management Instruction in the Nursing Curriculum

Nursing schools are in a unique position to address the gap in pain management knowledge through facilitating the acquisition and utilization of knowledge by the next generation of nurses (Duke et al., 2010; Zalon, 1995). However, current research on the knowledge and attitudes of nursing students and faculty demonstrate inconsistencies across nursing curricula (Duke et al., 2010; Plaisance & Logan, 2006). Researchers have also reported knowledge and attitude deficits regarding effective pain management among health care providers, evidence that inconsistent educational instructions carries over to inconsistent pain management (Baharuddin et al., 2010; Herr et al., 2004; Tanabe & Buschmann, 2000; Thomas, 2007).

Duke et al. (2010) documented the need to evaluate knowledge of pain assessment and treatment among nursing students. The investigation by Duke et al. (2010) indicated that on the semester before graduation senior students scored 68 percent out of 100 percent on a test of knowledge of and attitudes toward pain. With an acceptable benchmark of 80 percent set by the researchers, scores were well below the desired outcome. Duke et al. (2010) also demonstrated that faculty members performed slightly better, with a mean of 70 percent, reflecting less than optimal levels of knowledge and attitudes about pain assessment and management. Their results indicate that having pain management content in a nursing curriculum does not equate with having related knowledge (Duke et al., 2010).

Similar results were found by Plaisance and Logan (2006), who stated that the current state of nursing students' pain management knowledge is insufficient. Plaisance and Logan (2006) showed that students were unable to answer fundamental questions

related to analgesic routes, actions, and side effects (Plaisance & Logan, 2006). In fact, the majority of the students' scores for the Nurses' Knowledge and Attitude Survey Regarding Pain (NKASRP) were far below acceptable (Plaisance & Logan, 2006).

The knowledge of nursing students is influenced by multiple factors, including outdated and incorrect information from faculty, staff, and nursing curricula (Plaisance & Logan, 2006). Nursing faculty need to critically review their curricula in the area of pain management. Research has found a need for a reexamination of the amount of time, depth, breadth, and methods used to teach students about pain and pain management (Plaisance & Logan, 2006; Zalon, 1995). This would require a review of nursing textbooks and other resources for current evidence-based practice on pain management and for nursing faculty to incorporate recognized standards of pain management in nursing curricula (Plaisance & Logan, 2006). Overall, students need meaningful clinical experiences and role models who reinforce essential pain management knowledge and practice (Plaisance & Logan, 2006; Zalon, 1995).

For best practices in teaching and learning, faculty should assess student's knowledge, attitudes, and misconceptions early in the nursing curriculum, prior to the presentation of the new content (Briggs, 2010). Nursing faculty may also deem it necessary to revisit the topic of pain management throughout the course of study to ensure that students maintain appropriate practice (Briggs, 2010). An ideal amount of time allocated to pain management is not known and may be different for different nursing programs, depending on the conceptual framework and structure of the curriculum (Zalon, 1995). Most importantly, research suggests that alternative or

additional teaching innovations are needed to enhance student learning and understanding (Briggs, 2010).

Education of pain management using traditional learning and teaching methods has been found to increase knowledge and motivation but does not always change attitude, behavior, or practice (Keyte & Richardson, 2011). In order to improve education in the field of pain management, it is necessary to have a better understanding of how nurses learn about pain management and how to help them incorporate it into their clinical practice (Keyte & Richardson, 2011). Keyte and Richardson (2011) recommended an approach that incorporates problem-based learning (PBL) and e learning. PBL has the potential to simulate and explore real life pain problems within a safe learning environment where students use their experience, research, and debate with fellow students and facilitators. To create an environment conducive for PBL, Keyte and Richardson (2011) recommend incorporating computer-based technologies.

Improving nursing student's knowledge and attitudes toward pain management may well improve future patients' pain relief, thus providing the impetus to change decades of under treatment (Plaisance & Logan, 2006).

Pain Management in Nursing Professional Development

Consistent use of effective pain education programs for health care professionals, particularly for nurses who act as first-line personnel in pain assessment and treatment, is an urgent need and a vital strategy (Zhang et al., 2008). The quality of pain management depends on the knowledge, attitudes, and skills of those who provide the treatment (Zhang et al., 2008). Therefore, nurses need to have systematic training in pain related topics to enhance their knowledge and skills to manage pain (Zhang et al., 2008).

Research has found quantifiable evidence that pain management staff education programs can have a dramatic impact for professional nurses (Cui, Zhou, Zhang, Li, & Zhao, 2011; Long, 2011; Zhang et al., 2008).

Tse and Ho (2012) analyzed the effectiveness of a pain management program (PMP) in enhancing knowledge and attitudes of health care workers in pain management. The results demonstrated a statistically significant increase in total correct scores on tests of knowledge and attitudes toward pain management (Tse & Ho, 2012). The findings of this study show that adequate knowledge and attitudes toward pain management can enhance knowledge of pain management and staff development (Tse & Ho, 2012). Similar results were obtained in an investigation conducted by Zhang et al. (2008) in which nurses improved their knowledge and attitudes toward pain management after implementation of a pain education program. The scores of the nurses on the Nursing Knowledge and Attitude Survey increased steadily throughout the program (Zhang et al., 2008). The previously mentioned research studies serve as evidence of the effectiveness of pain management educational programs.

However, pain management education programs are not always adequate. Results from a study conducted by Clarke et al. (1996) revealed that pain related information in professional development programs is quite variable. In fact, Clarke et al. (1996) found that orientation programs offered the least information to nurses about pain management. Non-pharmacology interventions to alleviate pain are one of the areas in which participants reported receiving the least amount of information (Clarke et al., 1996). Investigation by Clarke et al. (1996) found that post nursing school, participants report

contact with colleagues and experience as their source for learning about pain management.

Developing professional educational programs is a challenge because healthcare professionals bring various levels of knowledge, experience, and attitudes toward pain management to the programs (Heye & Goddard, 1999). Most pain education programs offer general education for all grades and types of health professionals (Schofield, 2012). Due to the complex nature of pain, it is difficult to address issues related to every subgroup such as acute, chronic, or cancer pain, as well as age-related needs such as those concerning children or older adults (Schofield, 2012). Additionally, professional development of nurses relies on voluntary sign-up for courses and often nurses receive little clinical support in terms of time for study.

Correct knowledge and informed attitudes do not automatically yield better pain management practice at bedside. In fact, the challenge of any quality improvement measure is translation of education into practice (Simpson et al., 2002). However, educational efforts are one of the means to intervene to correct false beliefs about pain assessment and management (Simpson et al., 2002). Competent, knowledgeable practitioners are the key to excellent patient outcomes (Plaisance & Logan, 2006).

Current Pain Management Teaching Strategies in Nursing

Pain education must begin by acknowledging the current attitudes and knowledge of the learners (Heye & Goddard, 1999). Providing only theory and information is not enough to change behavior (Heye & Goddard, 1999). A comprehensive plan for teaching the content that incorporates strategies to change behavior can yield more positive results than episodic teaching (Heye & Goddard, 1999).

Heye and Goddard (1999) recommend professional development programs that use the Greipp's model to teach pain management because it incorporates the components that affect both the nurse and patient in making decisions about pain. The Greipp's model starts with a survey that helps individuals examine what they know about pain, personal beliefs, and cultural orientation about pain. The pain survey can also serve as a discussion guide and a common starting point to discuss pain management concepts.

The second part of the Greipp's model focuses on pictures, people, and recollections. According to Heye and Goddard (1999) pieces of art from books or prints that portray individuals in postures of pain, depression, or rage invite active participation and discussion on beliefs and feelings about pain. Similarly, showing movies or videotapes can vicariously teach the detrimental effect that the beliefs and attitudes of others can have on the patient as well as teaching the characteristics and management of chronic pain (Heye & Goddard, 1999). On the other hand, reading patient recollections can be a very revealing and disquieting experience for some learners since the recollections usually contain graphic information about sensations, feelings, and healthcare professionals (Heye & Goddard, 1999). This exercise helps learners realize the impact of clichés on patients in pain (Heye & Goddard, 1999).

The third part of the Greipp's model concerns the learner's potential inhibitors of the patient. These potential inhibitors are the patient's attributes that potentially influence adequate pain management such as culture, personal experiences, and beliefs (Heye & Goddard, 1999). The potential inhibitors influence the patient's physiologic, verbal, and non-verbal expressions of pain. The Greipp's model recommends teaching this type of content using an actual patient situation with case studies, or with role playing

simulations (Heye & Goddard, 1999). In this method, learners can review the scenarios, identify relevant variables of the nurse and patient, and identify the essential knowledge that affected decisions and patient outcomes (Heye & Goddard, 1999). In general, the Greipp's model is a proactive comprehensive theoretical approach to teaching pain management (Heye & Goddard, 1999).

The majority of hospitals and medical institutions' pain management education strategies consist of workshop programs. One program referenced in the literature was an 8-week pain management program (PMP) (Tse & Ho, 2012). The program consisted of two concurrent 1-hour sessions per week over 8 weeks (Tse & Ho, 2012). The content of the program focused on common types of pain management strategies in nursing, including pain assessment, pharmacology, drug addiction and dependence, side effects, and non-pharmacologic management strategies (Tse & Ho, 2012). The organizers of the pain management program tapped into adult learning strategies with the use of interactive methods relevant to the daily experience of the learners (Tse & Ho, 2012). The PMP included reality and clinic-based scenarios that reflected pain conditions among patients. Additionally, the program included practical sessions to assess the patient's pain and monitor the effects and side effects of drug therapy. In this way, the nursing staff could directly apply the knowledge gained from the PMP (Tse & Ho, 2012). Group discussions and face-to-face interactions were also used. Lastly, organizers of the PMP produced scenario-based video clips and broadcast these in class to stimulate discussion and understanding of the pain management concepts (Tse & Ho, 2012).

Another educational program referenced in the nursing literature was a Pain Education Program (PEP) designed to improved knowledge and attitudes about pain and

pain management (Zhang et al., 2008). The objective of the PEP was to improve pain assessment skills and behaviors in the clinical practice of nurses (Zhang et al., 2008). The PEP consisted of two components: an education program and clinical demonstration to implement daily pain assessment. The duration of the program was five weeks and it included focused education, group activity, and individual instruction (Zhang et al., 2008). The pain education component consisted of three, two-hour sessions that covered a specific pain assessment and management topic (Zhang et al., 2008). The clinical demonstration component included demonstrations on the use of pain scales to assess patients' pain levels and how to document the pain condition in the nursing records (Zhang et al., 2008). Overall, the education program consisted of formal lectures, discussion sessions, educational materials, practice with a simulated patient, and case-based discussion (Zhang et al., 2008).

Hospitals and other medical institutions do not always have sufficient resources to incorporate professional development programs that have the sound theoretical construct described in the Greipp's model. These hospitals and medical institutions must rely on other strategies. One strategy is to hire staff members whose role is to improve pain management practices (Ladak et al., 2011). These staff members are part of the Pain Resource Nurse (PRN) program (Ladak et al., 2011). The expectation of this role is to receive advance education on pain assessment and management to improve pain management practices in patient care areas (Ladak et al., 2011). In their roles, PRNs are visible on inpatient units and are constantly available to coach nursing staff in improving pain management practices (Ladak et al., 2011). Educational interventions such as the PRN programs can potentially create more awareness and help improve nurses'

knowledge of pain assessment and management techniques (Ladak et al., 2011). A recent study conducted by Ladak et al. (2011) on the experience of the PRN role implementation at a three-site academic health science center found that PRNs believed their role modeling of effective pain management in practice was effective in “getting the pain management message out” to their colleagues (Ladak et al., 2011).

In recent years, authors have called for the use of the Internet as a tool for delivering education to nurses (Schmitt, Titler, Herr, & Ardery, 2004). Unlike traditional forms of instruction, web-based instruction is available 24 hours a day, 7 days a week. This eliminates the need for duplicate lecture-style sessions and provides consistency in presentation of content (Schmitt et al., 2004). Web-based instruction provides advantages for the institution in that it eliminates the travel costs and for the learners in that it can provide more varied stimulation than traditional lecture-based instruction, resulting in improved attention (Schmitt et al., 2004).

Review of the literature found only one study that used the Internet for pain management continuing education by staff nurses working in acute care (Schmitt et al., 2004). The project educated nurses about evidence-based acute pain management practices for older adults using a web-based, self-instructed, continuing education course (Schmitt et al., 2004). The course content was developed with evidence-based practice guidelines for pain management and supplemented with evidence-based literature on treatment considerations related to aging, routes of analgesic administration, and use of epidural administration (Schmitt et al., 2004). A web-based learning management system housed the materials, quizzes, and evaluation forms for the program and provided the learners with immediate feedback on their quiz scores. Evaluations of the course content

were highly favorable and nurses indicated that the course was successful in meeting its objectives (Schmitt et al., 2004). Additionally, the learners mastered the course content with a high degree of success (Schmitt et al., 2004). Those that completed the course demonstrated mastery of the course content on evidence-based acute pain management practice for older adults (Schmitt et al., 2004).

Although an extensive review of the literature was conducted, no nursing education curriculum or professional development programs mentioned the use of computer or web-based simulations to teach and/or train pain assessment and management. In summary, an important outcome for patients is the safe and effective pain management strategies (Fry et al., 1999). The development of safe clinical policies and appropriate pain education is needed to ensure timely and proper control of the patients' pain (Fry et al., 1999). The research indicates that there is a knowledge gap among nurses regarding pain assessment and management (Nocera, 2002). It is evident that nurses and nursing students must increase their knowledge about pain management to provide effective care to patients (Nocera, 2002). Effective pain assessment and management strategies will improve the experiences of patients, increase role satisfaction for nurses, and enhance practice standards in clinical environments (Thomas, 2007).

Comprehensive Summary

Simulations and animated agents are a powerful way to open up a classroom to new and innovative learning experiences (DeLeon, 2008; Rickel et al., 2002; Schmidt, 2003). Used appropriately, computer-based simulation environments with animated agents provide not only something visually pleasing and entertaining to look at, but enables the use of certain communication protocols of face-to-face conversation that

facilitate user interaction and provide for a richer and more robust channel of communication than is afforded by any other mediated channel available today (Cassell, 2001).

As instructional researchers, our primary commitment must be to tease out the active ingredients in instruction that provide learning and motivation benefits to students or economic benefits to those who provide education and training (Clark & Choi, 2005). Adequate research design and a concern for current theories of learning and instruction will help us develop accurate evidence for the benefits of new technologies (Clark & Choi, 2005). Research on computer-based simulation with animated agents should incorporate several principles that will increase the utility of agents as social, emotional companions in a learning environment. Although, the future of interactive learning environments remains to be seen, animated agents will almost certainly populate our near future, guiding us toward opportunities to learn and enjoy.

In order to adequately investigate the potential of computer-based simulation with animated agents, new applications such as eye tracking (van Gog & Scheiter, 2010) and emotional facial coding systems (Zeng et al., 2009) can be used to increase knowledge on learning processes and to improve the design of instruction. In general, eye movements are necessary and essential during learning of visually presented materials; therefore eye movement registration can be employed without introducing any additional tasks extraneous to learning (Hyönä, 2010). Similarly, machine analysis of human affect can provide unobtrusive insight into the emotional experiences of learners as they interact with an affective interface. The use of an emotional facial coding system helps researchers determine if the affective component of the interfaces area relevant to the

learning experiences and if their inclusion or exclusion ultimately affects performance outcomes.

This investigation on computer-based simulations with animated agents helps evaluate the amount and nature of training needed to produce lasting effects. Especially when considering different levels of learners' expertise. Analysis of the structure of expert performance and of the learning processes by which experts improve will provide investigators with a better understanding of the potential for and limits of human learning and adaptation (Ericsson & Lehmann, 1996). Ideally, the investigation of computer-based simulations with animated agents could provide valuable information about the physiological behaviors, performance, and outcomes of novice versus experienced participants.

Lastly, as expressed in the literature, research about nurses' pain management knowledge and skills should consider innovative approaches that can provide insights into nurses' thinking about the patients' pain. Research is needed regarding the instructional strategies, timing, and placement of content related to pain and effective pain management interventions (Duke et al., 2010). This research on computer-based simulations with animated agents could inform the use of experiential components to increase nurses' pain management knowledge and skills. This research provides the foundation for further interventions to improve nursing education and patients' pain relief.

Research Questions and Hypotheses

The focus of this research was to investigate the effects of emotionally responsive agents in simulation-based training. Specifically, this research assessed how the presence

of an emotive, animated agent affects the visual attention, emotional responses, and performance of individuals interacting with a computer-based simulated environment. Additionally, this study investigated how visual attention, emotional responses, performance, and perception outcomes varied depending on the level of expertise (i.e., nursing students or experienced nurses) of the participant. This research informs current literature concerning animated agents and simulation design for training of personnel who interact with emotionally distressed clients. The research questions and hypotheses guiding this study were:

- Does a highly emotive animated agent affect the participants' visual attention, emotional response, and performance scores compared to those interacting with a medium or low emotive human-like agent? (Research Question 1)
 - Experienced participants will have greater visual attention on task-relevant information during the pain assessment interviews than the novice participants (Hypothesis 1).
 - Experienced participants will convey more neutral facial expressions during the pain assessment interviews with the animated agents than novice participants (Hypothesis 2).
 - Experienced participants will achieve higher simulation performance scores on the pain assessment and management task than novice participants (Hypothesis 3).
- Do experienced participants have a more positive perception (i.e., facilitator of learning, credible, human-like, and engaging) of the animated agents presented in the simulated environment than novices? (Research Question 2)

CHAPTER III

METHOD

Independent Variables

This study was a quantitative investigation that utilized a 3 (within) x 2 (between) x 3 (within) mixed factorial design. Independent variables included emotion intensity, levels of expertise, and trials, respectively.

Emotion Intensity

The emotion intensity refers to the level of the emotion portrayed by three animated agents. The emotion intensity of the three agents was controlled using body movement, verbal communication, and behaviors. In the nursing simulation developed for this research project, the emotion intensity was equivalent to observed conduct expected for specific pain scores as measured by the Visual Analog Scale.

The animated agent with low emotion intensity had a pain score of three. This animated patient portrayed a neutral expression and was able to talk normally (P. Atkinson, Chesters, & Heinz, 2009). The animated agent with moderate emotion intensity had a pain score of six. This animated agent was very protective of the affected area, had less movement, and complained of pain (P. Atkinson et al., 2009). The animated agent with high emotion intensity had a pain score of nine. This animated agent was restless, unsettled, complained about lots of pain, and cried inconsolably (P. Atkinson et al., 2009).

A validation study of the emotion intensity rendering of the animated agents was conducted prior to the use of the nursing simulation. A group of nursing experts rated

each emotion intensity rendering and made suggestions for improvements to the observed conduct portrayed by the animated agents (see APPENDIX A).

Levels of Expertise

The levels of expertise categorized participants as either novice or experienced on pain assessment and management. For this research study, a novice participant was defined as an undergraduate nursing student in the third (junior) or fourth (senior) year of college education. An experienced participant was defined as a professional nurse with three or more years of experience in a clinical setting.

Trials

The study design required that each participant complete three trials, each with an animated agent rendering a different level of emotion intensity. For each trial, the participant had to successfully complete an equivalent pain assessment and management nursing simulation critical path. Six possible random orders for the interactions with the animated agents were pre-arranged for each participant as shown in Table 1.

Table 1

Order of Interactions with the Animated Agents

| Order | 1 st Trial | 2 nd Trial | 3 rd Trial |
|-------|-----------------------|-----------------------|-----------------------|
| | Emotion Intensity | Emotion Intensity | Emotion Intensity |
| 1 | Low | Moderate | High |
| 2 | Moderate | High | Low |
| 3 | High | Moderate | Low |
| 4 | Low | High | Moderate |
| 5 | Moderate | Low | High |
| 6 | High | Low | Moderate |

Dependent Variables

Four main dependent variables were measured in this dissertation study. First, visual attention was assessed through eye tracking data (i.e., gaze time) of gaze in pre-specified areas of interest (AOI) of the simulation. Second, the participants' emotional response toward the animated agent was quantified by a facial expression encoding system. Third, the performance of the participant was measured through a simulation performance score. Fourth, the participants' perception of the animated agent persona (i.e., facilitating learning, credible, human-like, and engaging) was measured using a validated "Agent Persona Instrument" (Ryu & Baylor, 2005).

Participants

A total of 56 paid participants consented to complete the study. Notices to participate in the study were sent out through the Old Dominion University announcement system, social networking sites, bulletin board fliers, and email. Ninety-four percent (n=51) of the participants were female and five percent (n=3) were males. Participants rated their level of experience with computers as experts (n=2), proficient (n=27), intermediate (n=23), beginners (n=2) and novices (n=1). Participants reported using their computer skills to email (94.6%), browse the Internet (92.9%), engage in word processing (71.4%), social networking (67.9%), complete distance education courses (35.7%), process accounting/finance (33.9%), play entertainment games (14.3%), play educational games (3.6%), and produce graphic design (1.8%). Ninety-three percent (n=50) of the participants were native English speakers and seven percent (n=4) spoke English as a second-language.

Inclusion Criteria

Twenty-seven novice participants were recruited from public universities in the southeastern United States that offered nursing programs and twenty-nine experienced participants were recruited from local area hospitals and other clinical settings. Novice participants included third-year (21.4%) and fourth-year (78.6%) students in undergraduate-nursing programs. Experienced participants, alternatively, included professional nurses with three or more years of work experience in a hospital or other clinical settings.

Participants had clinical experience with pain assessment and management, 21.4% had one year of experience, 17.9% had two-years of experience and 61.2% had three years of experience or more. The participants' prior knowledge and attitudes about pain in nursing reported using the Nurses' Knowledge and Attitude Survey Regarding Pain ranged from 14 to 33 points ($M = 24.93$). Nursing students scored an average of 24.07 points and experienced nurses an average of 25.85 points.

Exclusion Criteria

An exclusion criterion was used to control for some of the variance associated with reaction time to the nursing simulation stimuli for participants who were age 65 or older. Research on the variability of reaction time performance of adults has provided evidence that participants age 65 or older have slower reaction time to the stimuli than participants that are 64 years old or younger (Der & Deary, 2006; Hultsch, MacDonald, & Dixon, 2002; Myerson, Robertson, & Hale, 2007). Therefore, those age 65 years or older were excluded from participation in this research study. Overall, 26.9% of the

participants were 18 to 25 years old, 28.8% were 26 to 35 years old, 26.9% were 36 to 50 years old, and 17.3% were 51 to 64 years old.

Material

Simulation

The title of the simulation was “Pain Management in the Emergency Department.” The primary objectives of the simulation included: confirmation of the patient’s identity, evaluation of the patient (including vital signs and pain assessment), determination of correct nursing care for the patient based on assessed conditions and demonstration of appropriate care in a safe manner. Participants in this study were expected to correctly address each of the pain management critical path actions and complete a pain assessment interview with the animated patient to eradicate the pain complications of the patients.

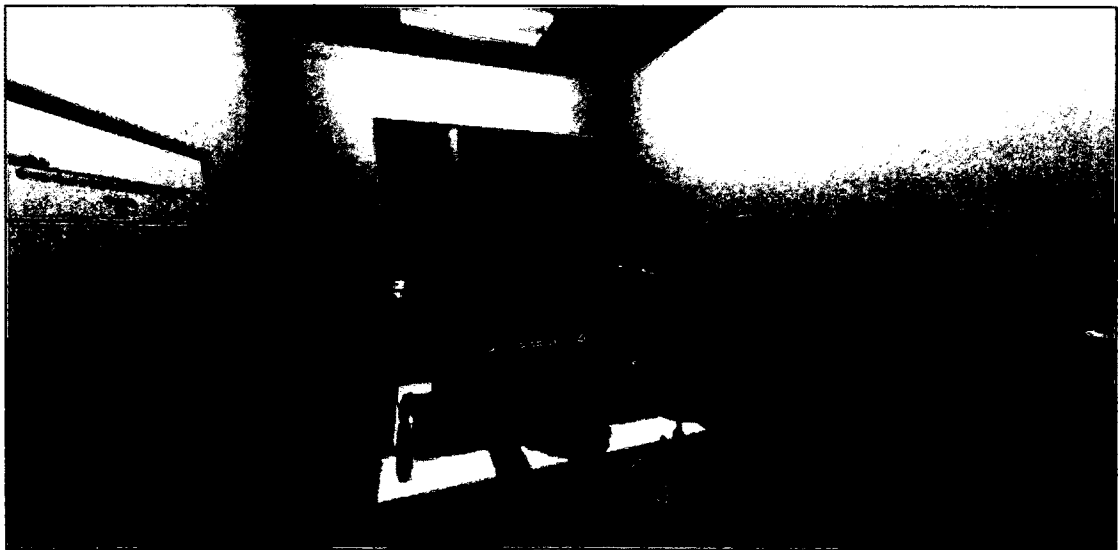


Figure 1. Pain Management in the Emergency Department Simulation

In the simulation, the participants interacted with three animated patients in a clinic shown in Figure 1. The animated patients were co-workers in a business trip. They

were playing golf earlier in the day and their golf cart flipped over. The patients were complaining of abdominal pain and adopting positions of discomfort. The three patients varied in their ethnicity and age. Detailed patient medical records were available in the simulation. Refer to APPENDIX B. for an in depth description of the simulation “Pain Management in the Emergency Department.”

Before the interaction with the simulation environment, each participant read an introduction to the simulation (see Figure 2), the objectives of the simulation (see Figure 3), the details of the scenario (see Figure 4), and instructions on how to interact with the simulation environment (refer to APPENDIX C) from a webpage developed by the researcher. Participants received a “Simulation Objects Handout” paper document as a guide to active, clickable objects in the patient rooms (refer to APPENDIX D).

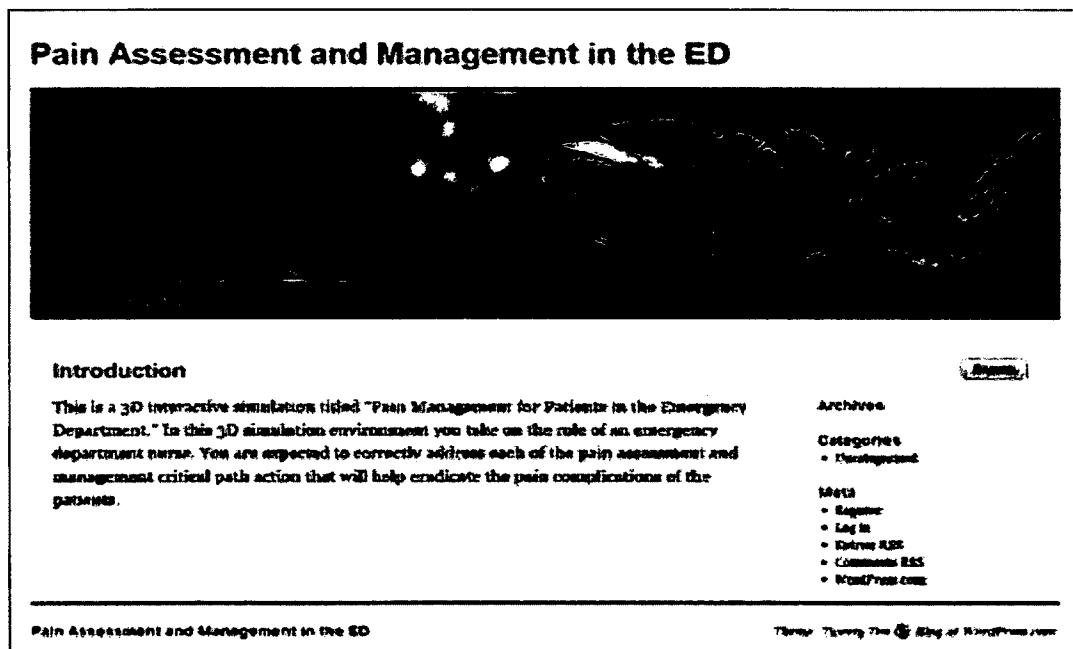
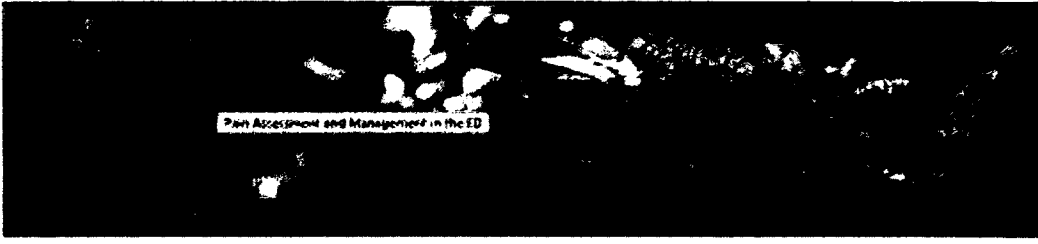


Figure 2. Introduction to the Simulation

Pain Assessment and Management in the ED



Pain Assessment and Management in the ED

Objectives

After interacting with this 3D interactive simulation, you will be able to:

- Correctly confirm a patient's identity.
- Apply proper nursing actions to initiate care of a patient.
- Evaluate a patient, including vital signs and pain assessment.
- Determine the nursing care for a patient based on assessed patient condition as well as reported and observed pain assessment.
- Implement the appropriate pain management care of a patient in a safe manner.

Archives

Categories

- Unassigned

Meta

- All
- None
- All
- All
- All
- All

Archives

Categories

- Unassigned


Meta

- All
- None
- All
- All
- All
- All

Pain Assessment and Management in the ED
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Figure 3. Objectives of the Simulation

Pain Assessment and Management in the ED



Pain Assessment and Management in the ED

Scenario

It is the day shift and you will provide care to Jose Rodriguez, Lin Chan, and Arthur Smith, patients who arrived to the emergency department. The patients were playing a golf game earlier in the day and their golf cart flipped over. All three patients are alert and orientated to person, place, and time. Dr. Scott, the physician, already assessed the patients and left medical orders.

This will be your first encounter with the patients. The patients are complaining of abdominal pain and adopting positions of discomfort. They also have some contusions, bruising in the forehead, and black and blue mark on shoulder from the seat belt. The lab work has been done for the patients. Detailed patient medical records for each patient are available in the simulation environment.

Archives

Categories

- Unassigned

Meta

- All
- None
- All
- All
- All
- All

Archives

Categories

- Unassigned

Meta

- All
- None
- All
- All
- All
- All

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Figure 4. Scenario Description

Instruments

Demographic Questionnaire

Before participants entered the simulated environment, they were asked to complete a demographic questionnaire (refer to APPENDIX E). The data collected through the demographic questionnaire included: sex, age group, native language (i.e., English or other), level of computer experience (i.e., novice, competent, expert), hours of computer usage at work and home, type of computer usage (e.g., social networking, gaming, research and others) and other demographic data.

Expertise Questionnaire

In addition to the demographic questionnaire, participants completed the expertise questionnaire. The expertise questionnaire was used to categorize participants as either novice or experienced individuals on pain assessment and management (see APPENDIX F). Five questions were asked in the questionnaire. Two questions in the questionnaire directly assessed if the participant was a novice individual (i.e., enrollment status in nursing school and the current level of nursing school education). Alternatively, one of the questions directly assessed if the participant was an experienced individual (i.e., years of professional experience in a clinical setting). The other two questions gathered information on the number of college courses completed on the topic of pain management and years of clinical experience that the participants had with pain assessment and management.

Nurses' Knowledge and Attitude Survey Regarding Pain

To assess the participants' pre-existing general knowledge on pain assessment and management, the participants completed the Nurses' Knowledge and Attitudes Survey

Regarding Pain (NKASRP). The NKASRP is a self-administered inventory that contains 37 items (Duke et al., 2010; Plaisance & Logan, 2006). The inventory includes 22 true or false items, 13 multiple-choice items, and two patient-care scenario items (refer to APPENDIX G). The maximum number of points that can be obtained is 39. The instrument was originally developed in 1987 and has been revised several times since then (Plaisance & Logan, 2006; Voshall, Dunn, & Shelestak, 2012). The inventory has an acceptable test re-test reliability ($r > .80$) and internal consistency reliability (alpha $r > .70$) (Duke et al., 2010; Plaisance & Logan, 2006; Voshall et al., 2012). The NKASRP has been used as a research instrument to assess nurses' knowledge and attitudes regarding pain by several researchers (Duke et al., 2010; Plaisance & Logan, 2006; Tse & Ho, 2012; Voshall et al., 2012; Zhang et al., 2008). To avoid a predisposition towards the pain assessment and management tasks in the simulation, participants completed the NKASP after the simulation tasks was completed.

Eye Tracker

An eye tracker was used to collect visual attention measures. Eye tracking allows the researcher to register the position of the eyes while they move across visual stimuli (Scheiter & van Gog, 2009). In this manner, measures can be collected on the distribution of visual attention in terms of what objects are attended to, for how long, and in what order. Today, researchers use eye tracking analysis to study scene perception, aviation, and driving (Holsanova et al., 2009). Eye tracking methodology is also used in research related to neuroscience, psychology, industrial engineering, human factors, computer science, marketing and advertising (Boucheix & Lowe, 2010; Canham & Hegarty, 2010; de Koning et al., 2010; Duchowski, 2003; Jarodzka et al., 2010; K. Meyer et al., 2010;

Schmidt-Weigand et al., 2010). A primary application of eye tracking methodology is usability testing (Scheiter & van Gog, 2009). Among various experiments, eye movement are used to evaluate the grouping of tool icons, compare gaze-based and mouse interaction techniques, evaluate the organization menus, and to test the organization of a webpage (Duchowski, 2003).

To gain an understanding of the visual attention of the participants while they interacted with the simulated environment and the animated agent, the researcher analyzed visual attention data from an eye-tracking system. The researcher defined areas of interest in the simulation interface that were task-relevant to the successful completion of the pain assessment interview with the patient. Specifically, during the pain assessment interview three areas of interest were defined: the face and shoulder of the animated patient, the torso and legs of the animated patient, and the interview questions pop-up box (as shown in Figure 5). The pain assessment interview constituted the moment in the interaction in which the participants interacted directly with the animated patient. As participants answered the seven pain assessment interview questions, eye tracking data monitored the number of fixations and fixation time on the pre-defined areas of interest.

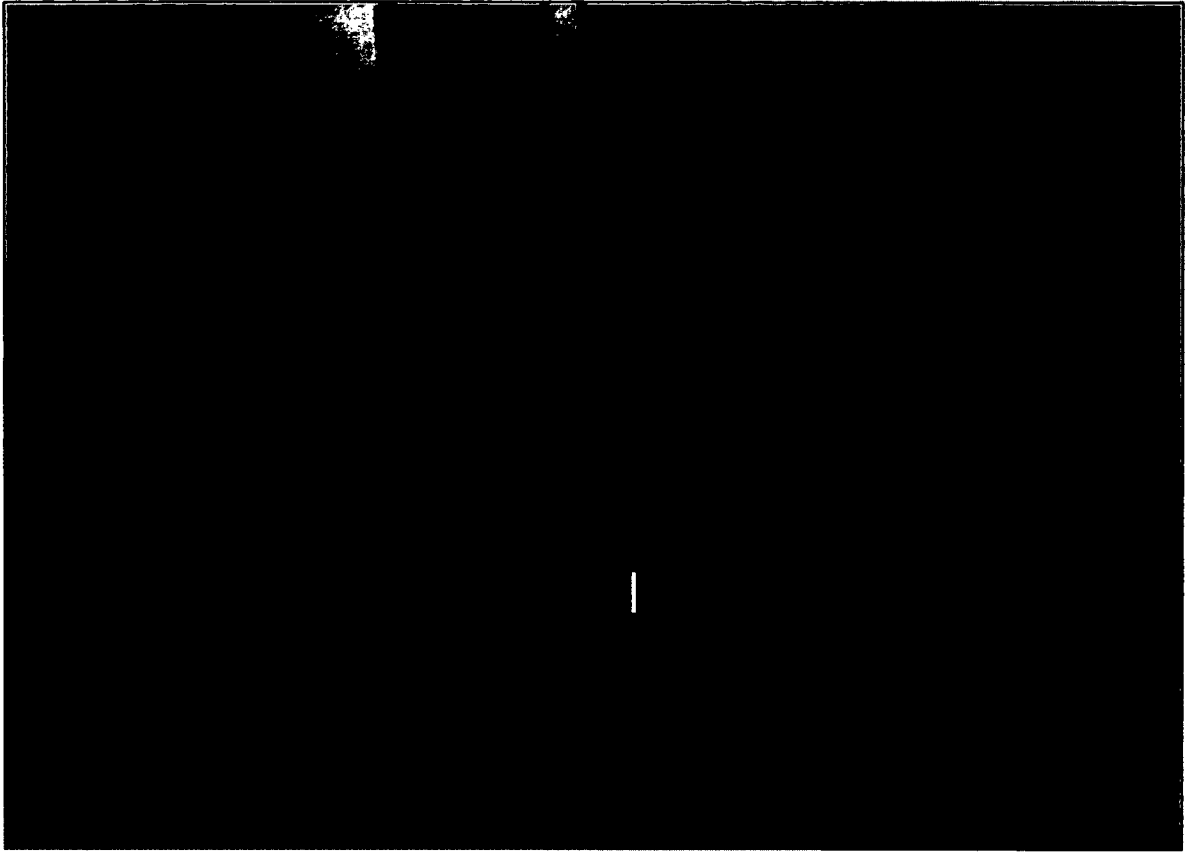


Figure 5. Areas of Interest in the Simulation Environment

The researcher used a Smart Eye Pro two-camera (see Figure 6), heads-free eye-tracker to record participants' eye movements during the interactions with the simulation, which was displayed on a 17" monitor. The eye tracking system is capable of deducing the full 6 Degree of Freedom (DOF) positions of the head relative to the monitor as well as tracking the eye gaze. Typical accuracy for the head tracking portion of the system is 0.5 degrees in rotation and less than 1mm in translation. The typical accuracy of the gaze vector is 0.5 degrees. The system utilizes facial and other features to first identify the location of the head. Once the location of the head is identified, infrared reflections of the eye are used to compute the gaze relative to the head. All of this is transparent to the participant, with the only requirement of the participant being a short (less than 2

minutes) registration period in which the eye-tracker identifies facial features that facilitate tracking.



Figure 6. Eye Tracking using Smart Eye Pro

The eye-tracking system was configured to deliver a variety of raw and derived data at the 60 Hz sampling rate. Raw data included the head position, eye gaze direction, as well as the coordinates of the intersection of the eye-gaze with the screen. Other derived data include glance patterns and AOI visual attention. The entire eye tracking system was connected to the computer used by the participants.

FaceReader

The FaceReader is software that uses video of a person's face to analyze the emotional facial expressions of the user (Choliz & Fernandez-Abascal, 2012; Goldberg, 2012; Gorbunov et al., 2012; Harley et al., 2012; Melder et al., 2007; Smets et al., 2012; Terzis et al., 2010; Uyl & Kuilenburg, 2005; Zaman & Shrimpton-Smith, 2006). Within each video frame, this software initially finds the user's face (Goldberg, 2012). In order to accurately find the position of the face, the software uses the Active Template Method (Uyl & Kuilenburg, 2005). This method displaces a deformable face template over an image, returning the most likely position of the face to be analyzed (Choliz & Fernandez-

Abascal, 2012; Uyl & Kuilenburg, 2005). Then, the FaceReader uses a model-based method called the Active Appearance Model (AAM) to synthesize an artificial face model (Chentsova-Dutton & Tsai, 2010; Choliz & Fernandez-Abascal, 2012; Goldberg, 2012; Grootjen et al., 2007; Harley et al., 2012; Melder et al., 2007; Uyl & Kuilenburg, 2005). The model then assigns 491 facial features locations and describes the texture of the face (Goldberg, 2012; Uyl & Kuilenburg, 2005).

The final stage in the architecture of the FaceReader is the classification of the facial expression (Choliz & Fernandez-Abascal, 2012). This is done by entering the AAM values in a trained artificial neural network (Harley et al., 2012; Melder et al., 2007; Uyl & Kuilenburg, 2005). The network is trained using the Karolinska Directed Emotional Faces set containing 980 high quality facial images (Melder et al., 2007; Uyl & Kuilenburg, 2005) and the facial actions described in the Facial Action Coding System (Bernhaupt et al., 2007; P. Ekman & Friesen, 2003; Paul Ekman, 2007; Gorbunov et al., 2012; Harley et al., 2012; Terzis et al., 2012; Uyl & Kuilenburg, 2005; Zaman & Shrimpton-Smith, 2006). The trained artificial neural network is qualified to classify the facial expressions in one of the six basic emotions: happy, angry, sad, surprised, scared, disgusted or neutral (Bernhaupt et al., 2007; Choliz & Fernandez-Abascal, 2012; Goldberg, 2012; Gorbunov et al., 2012; Grootjen et al., 2007; Terzis et al., 2010, 2012; Uyl & Kuilenburg, 2005; Zaman & Shrimpton-Smith, 2006). The software continuously calibrates as the face video is captured from the user and operates at a real-time video frame rate (Goldberg, 2012).

While there are several debates regarding the universality and reliability of facial expressions of emotions readings from a FaceReader (Biehl et al., 1997; Paul Ekman,

1994; Paul Ekman & Friesen, 1971, 1986; Paul Ekman et al., 1987; Matsumoto, 1989, 1990; Roberson, Damjanovic, & Kikutani, 2010; Russell, 1994), some investigations have confirmed the accuracy of facial expression readings (Harley et al., 2012; Uyl & Kuilenburg, 2005; Zaman & Shrimpton-Smith, 2006). Several validation studies have agreed that the FaceReader has an accuracy of 89% (Bernhaupt et al., 2007; Gorbunov et al., 2012; Melder et al., 2007; Terzis et al., 2010, 2012; Uyl & Kuilenburg, 2005; Zaman & Shrimpton-Smith, 2006). Additionally, the manufacturer quote the percentage of agreement for the six emotions as: happy, 97%; angry, 80%; sad, 85%; surprise, 85%; disgust, 88%; and fear, 93% (Choliz & Fernandez-Abascal, 2012). Uyl and Kuilenburg (2005) stated in their research that the FaceReader has trained networks on properties such as gender, ethnicity (Chentsova-Dutton & Tsai, 2010), age, and facial hair (i.e., beards and mustaches).

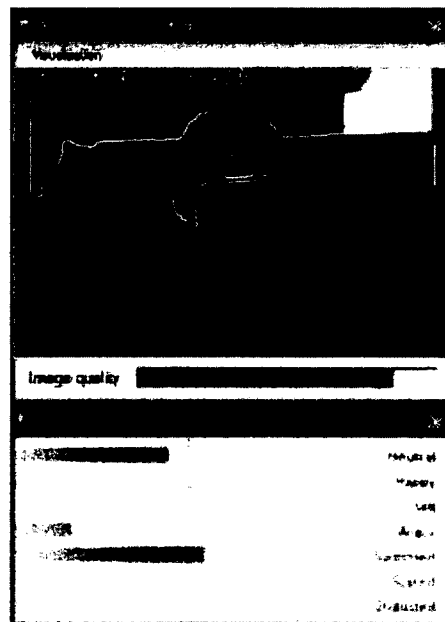


Figure 7. Facial Expression reading using the FaceReader

Other facial recognition systems are available (Kapoor & Picard, 2002; McDuff, Kaliouby, Kassam, & Picard, 2001; Scheirer, Fernandez, & Picard, 1999; Vyzas & Picard, 1999). However, due to its accuracy in facial expression analysis and its commercial availability, the FaceReader (shown in Figure 7) was used for this research. Specifically, the researcher defined the pain assessment interview with the emotionally disturbed animated patient as the precise emotion-driven event for which the emotional response of the participant was measured. As participants conducted the seven pain assessment interview questions, emotion facial expression data was collected from the participants' faces. The facial expression data helped determine the participant's neutral, positive, and negative emotions during the interaction with the animated patients.

For this study, the FaceReader system consisted of the Noldus FaceReader 5.0 software and a webcam camera in a well-illuminated room (see Figure 6). The camera collected video feed while the participants interacted with the simulated agents. The software gathered facial expression information from the participants' face.

Simulation Performance Score

To measure the participants' ability to assess and manage pain in the simulated environment, a simulation performance score was calculated at the end of each participant's interaction. A performance report was developed to explain how the simulation calculated the scores. An important component of the performance report was the actions that the participants were expected to complete in the simulated environment. One point was given for each pain assessment and management action that was completed and zero points were given for actions that were not completed at all or for superfluous actions.

The performance report also incorporated points that the participants gained during the patient assessment interview. The interview allowed the participants to choose from three interview questions regarding pain assessment. One of the interview questions was the correct option that helped the participant assess the patient's pain. If the participant picked this option, he/she received two points. Another interview question was the second best option that the participant could ask to assess the patient. If the participant picked this option, he/she received one point. Lastly, one of the interview questions was irrelevant to the assessment of the patient. If the participant picked this option, he/she did not receive any points.

Overall, the performance report included points accumulated by the participant as he/she completed the critical path actions and the assessment interview.

Agent Persona Instrument

The agent persona instrument is a published instrument for the assessment of an animated pedagogical agent persona. The agent persona instrument has two main categories: the informational usefulness of the agent and the affective interaction of the agent (Ryu & Baylor, 2005). The construct for the informational usefulness constitutes two factors: facilitating learning and credibility. These two factors relate to the ability of the agent to enhance learning and to be perceived as a knowledgeable instructor (Ryu & Baylor, 2005). On the other hand, the construct for the affective interaction constitutes: human-like and engaging. With this two factors the agent is defined as having a human personality, good communication, emotional expression, believability, and a social presence (Ryu & Baylor, 2005).

The agent persona instrument has a total of 25 items (refer to APPENDIX H). Participants used a five-point Likert scale (i.e., 1 = strongly disagree to 5 = strongly agree) to rate each item in the instrument. Ten items rate the agent's ability to facilitate learning, five items rate the agent's ability to be credible, five items rate the agent's ability to be human-like, and five items rate the agent's ability to be engaging.

Procedure

Participants were tested individually. Recruitment procedures occurred over a three-month period. During the recruitment process, participants were asked to respond to a notice to participate in the study sent out through university and departmental listserv, university social networking sites, university bulletin board fliers, and email invitations. Once a participant contacted the researcher regarding participation in the study, an email was sent with registration and scheduling information. After the participant registered and scheduled the individual session, an email confirmation was sent to the participant with directions to the research facility. Recruitment continued throughout the data collection process until the desired number of participants was reached.

On the day of the session, the researcher greeted each participant and explained the purpose of the study. Participants were given time to carefully read and sign the consent forms (refer to APPENDIX I and APPENDIX J). A copy of the signed consent forms was provided to the participant and the original was kept by the researcher. After the consent forms were signed and photocopied, the participant completed a demographic questionnaire and an expertise questionnaire.

With the participant comfortably seated at the computer, the researcher briefed the participant on specific instructions for the task and details about the simulated

environment. The researcher then calibrated the eye tracker and created an eye tracker profile for each participant. The participant was then assigned to one of the six possible random trial orders. The FaceReader and eye tracking systems were started when the participant began interacting with the simulation. The simulation recorded the beginning and ending interaction times for each participant. All participants used the same computer and monitor throughout the session.

After the interaction with the simulation, the simulation calculated the performance score. Then, the knowledge and attitude survey regarding pain and the agent persona instrument were completed. Participants were thanked for their participation and were asked to sign the documentation of compensation form. Before leaving the research room, a gift card was given to the participant as compensation for participation in the research study. Initially, gift card compensation was \$15, however to increase participation gift card compensation was increased to \$30. Overall, participation lasted about 45 minutes to one hour.

CHAPTER IV

RESULTS

The study reported here examined the effects of emotionally responsive agents represented as emotionally distressed clients during simulation-based training. This chapter is organized in terms of the research questions and hypothesis posed in Chapter 2.

Research Question 1: Emotion Intensity of the Animated Agents

The results for the Research Question 1 are addressed within the data analysis of the following three hypotheses. The effect of emotion intensity of the animated agents are presented along with the analysis of visual attention, emotional responses, and simulation performance scores comparing experienced versus novice participants as detailed in Hypothesis 1, 2, and 3.

Hypothesis 1: Visual Attention

A multivariate analysis of variance (MANOVA) was conducted to examine the effect of participants' level of expertise and emotion intensity of the agent on the participants' visual attention. The dependent variable was gaze time. The independent variables were level of expertise (i.e., experienced nurses or nursing students) and emotion intensity of the animated agent (i.e., low, moderate or high). The results indicated that there was a significant main effect for level of expertise, $F(2, 119) = 5.703, p = .004$; Wilk's $\Lambda = 0.913$, partial $\eta^2 = .087$, but not a significant main effect for emotion intensity of the animated agent, $F(4, 238) = .713, p = .584$; Wilk's $\Lambda = 0.976$, partial $\eta^2 = .012$ or the interaction between level of expertise and emotion intensity, $F(4, 238) = .056, p = .906$; Wilk's $\Lambda = 0.991$, partial $\eta^2 = .004$.

To further examine the difference between levels of expertise, univariate follow-up procedures were conducted for the individual dependent variable (as shown in APPENDIX K). The results indicate that there was a statistically significant difference in the gaze time between experience nurses and nursing students ($F(1, 120) = 10.259; p = .002$; partial $\eta^2 = .079$), nursing students accumulated longer gaze time on average (as shown in Figure 8).

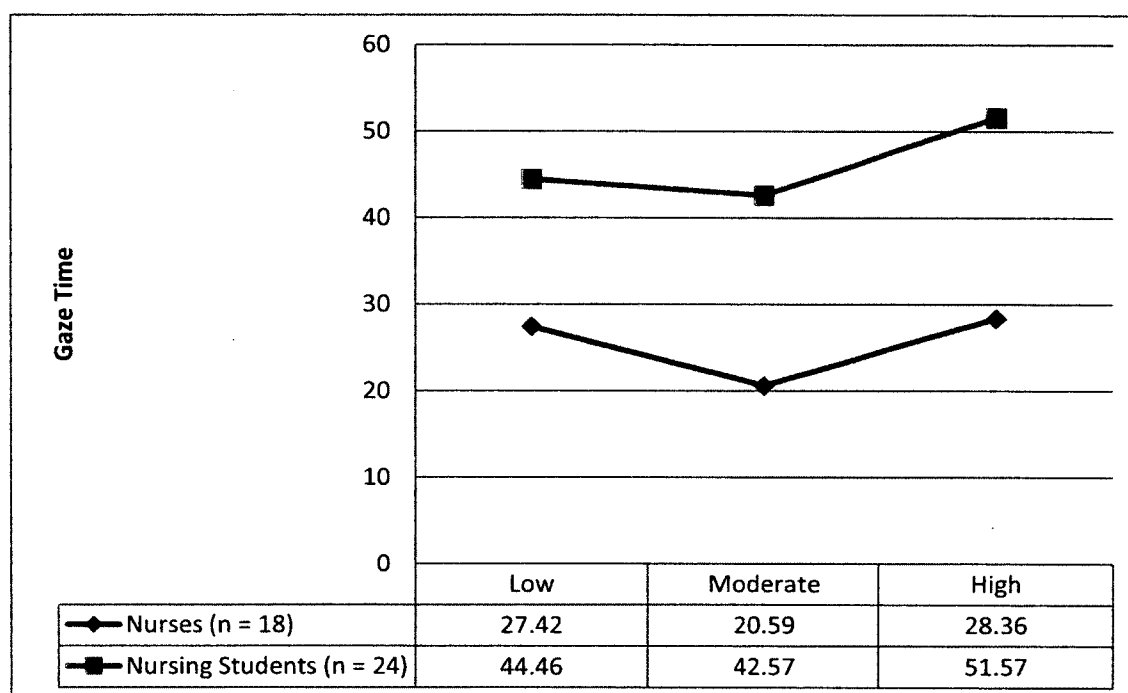


Figure 8. Mean Gaze Time by Emotion Intensity

A multivariate analysis of variance (MANOVA) was conducted to examine the effect of participants' level of expertise on the participants' visual attention areas of interest. The dependent variable was gaze time. The results indicated that there was a significant main effect for level of expertise, $F(2, 134) = 5.463, p = .005$; Wilk's $\Lambda = 0.925$, partial $\eta^2 = .075$, a significant main effect for area of interest in the simulated environment, $F(4, 268) = 12.729, p = .000$; Wilk's $\Lambda = 0.706$, partial $\eta^2 = .160$ and a

significant interaction between level of expertise and areas of interest in the simulated environment, $F(4, 268) = 5.268, p = .000$; Wilk's $\Lambda = 0.860$, partial $\eta^2 = .073$.

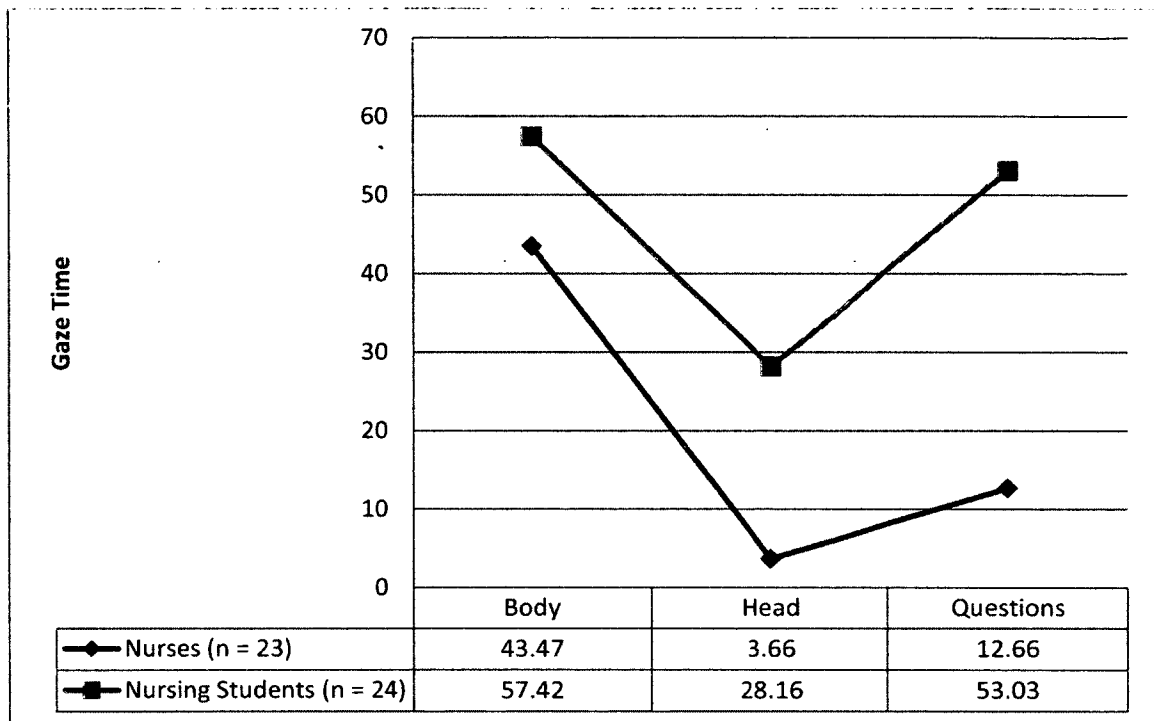


Figure 9. Mean Gaze by Areas of Interest of the Simulation

To further examine the difference between level of expertise in the areas of interest, univariate follow-up procedures were conducted. Results indicate that there was a statistically significant difference in the gaze time between experienced nurses and nursing students ($F(1, 135) = 8.916; p = .003$; partial $\eta^2 = .062$), nursing students demonstrated longer gaze time on average. The results also indicate that there was a statistically significant difference in gaze time between the areas of interest in the simulated environment ($F(2, 135) = 5.135; p = .007$; partial $\eta^2 = .091$), participants demonstrated greater number of gaze time on the torso and legs of the animated patients on average (as shown in Figure 9).

Hypothesis 2: Emotional Responses

A multivariate analysis of variance (MANOVA) was conducted to examine the effect of participants' level of expertise and the emotion intensity of the agent on the participants' emotional response. The dependent variables were neutral, happy, sad, angry, scared, and disgusted emotion. The independent variables were level of expertise (i.e., experienced nurses or nursing students) and emotion intensity of the animated agent (i.e., low, moderate or high). The results indicated that there was a significant main effect for level of expertise, $F(7, 74) = 2.555, p = .021$; Wilk's $\Lambda = 0.805$, partial $\eta^2 = .195$, but not a significant main effect for emotion intensity of the animated agent, $F(14, 148) = .547, p = .901$; Wilk's $\Lambda = 0.904$, partial $\eta^2 = .049$ or the interaction between level of expertise and emotion intensity, $F(2, 262) = .061, p = .972$; Wilk's $\Lambda = 0.998$, partial $\eta^2 = .001$.

To further examine the difference between levels of expertise, univariate follow-up tests were conducted for the individual dependent variables (as shown in APPENDIX L). The results indicate that there was a statistically significant difference in the percentage of neutral emotional responses between experienced nurses and nursing students ($F(1, 80) = 8.739; p = .004$; partial $\eta^2 = .098$). Nursing students displayed a higher percentage of neutral emotional response towards the animated agents. There was also a statistically significant difference in the percentage of disgusted emotional responses between experienced nurses and nursing students ($F(1, 80) = 4.940; p = .029$; partial $\eta^2 = .058$). Experienced nurses displayed a higher percentage of disgusted emotional responses towards the animated agents (as shown in Figure 10 and Figure 11).

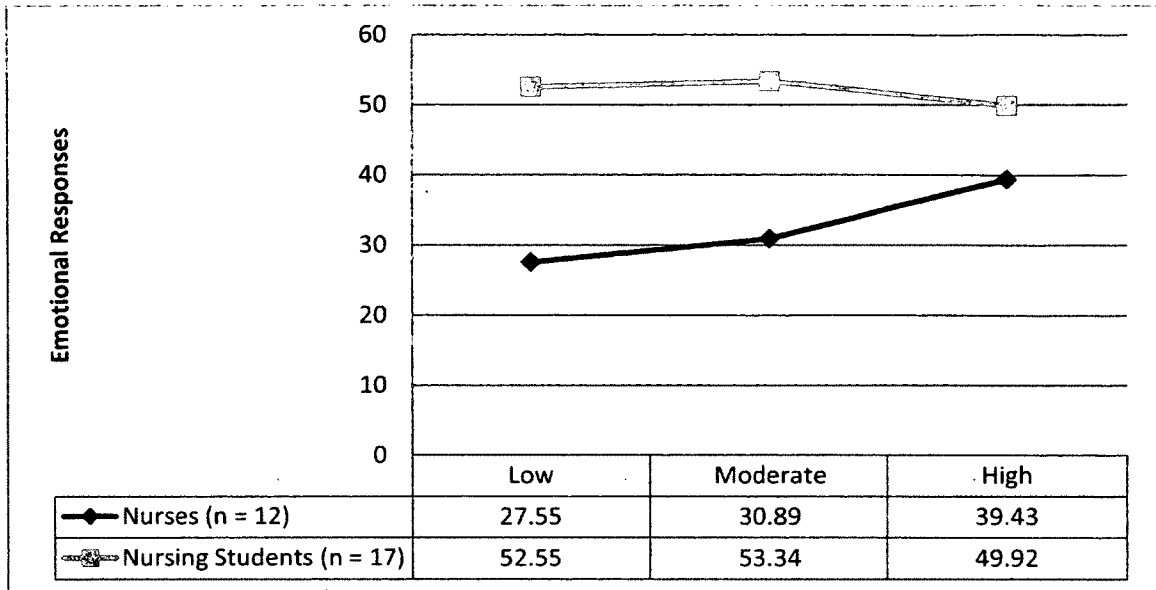


Figure 10. Mean Neutral Emotional Responses by Emotion Intensity

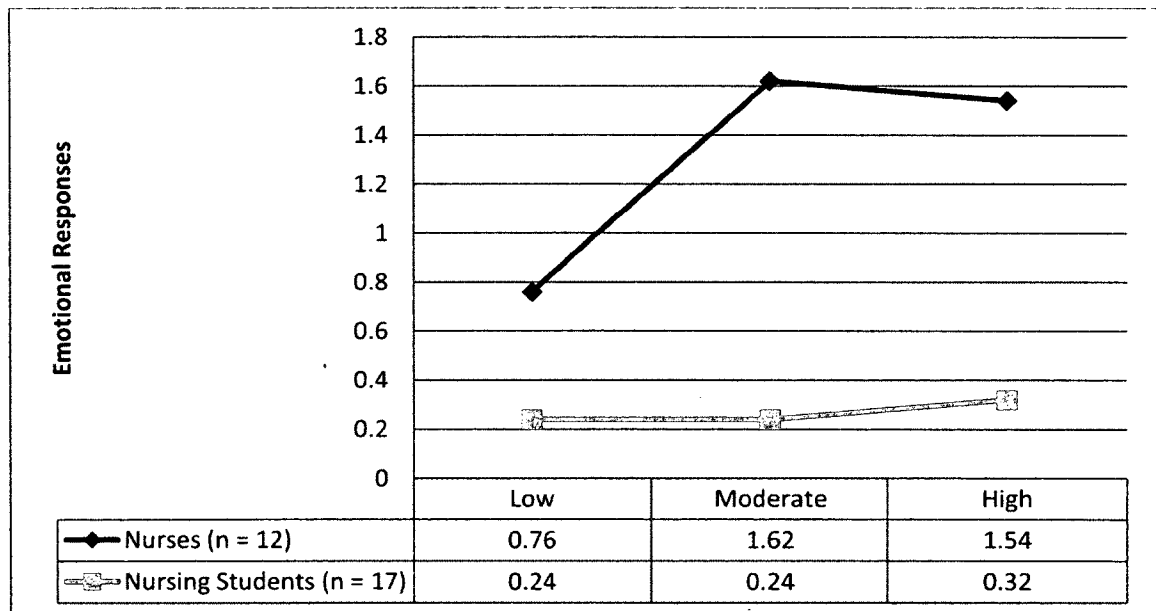


Figure 11. Mean Disgusted Emotional Responses by Emotion Intensity

Hypothesis 3: Simulation Performance Scores

A two-way analysis of variance (ANOVA) was conducted that examined the effect of level of expertise and emotion intensity on the simulation performance scores of experienced nurses and nursing students (as shown in APPENDIX M). Simple main effects analysis showed that nursing students obtained significantly higher simulation performance scores than experienced nurses, $F(1, 162) = 21.498, p = .000$. There were no statistically significant differences between simulation performance scores when comparing the emotion intensity of the animated agents in the simulation, $F(2, 162) = .521, p = .595$. Also, the statistical analysis indicated that there was no significant interaction between level of expertise and emotion intensity on the simulation performance scores of the participants, $F(2, 162) = .388, p = .679$ (as shown in Figure 12).

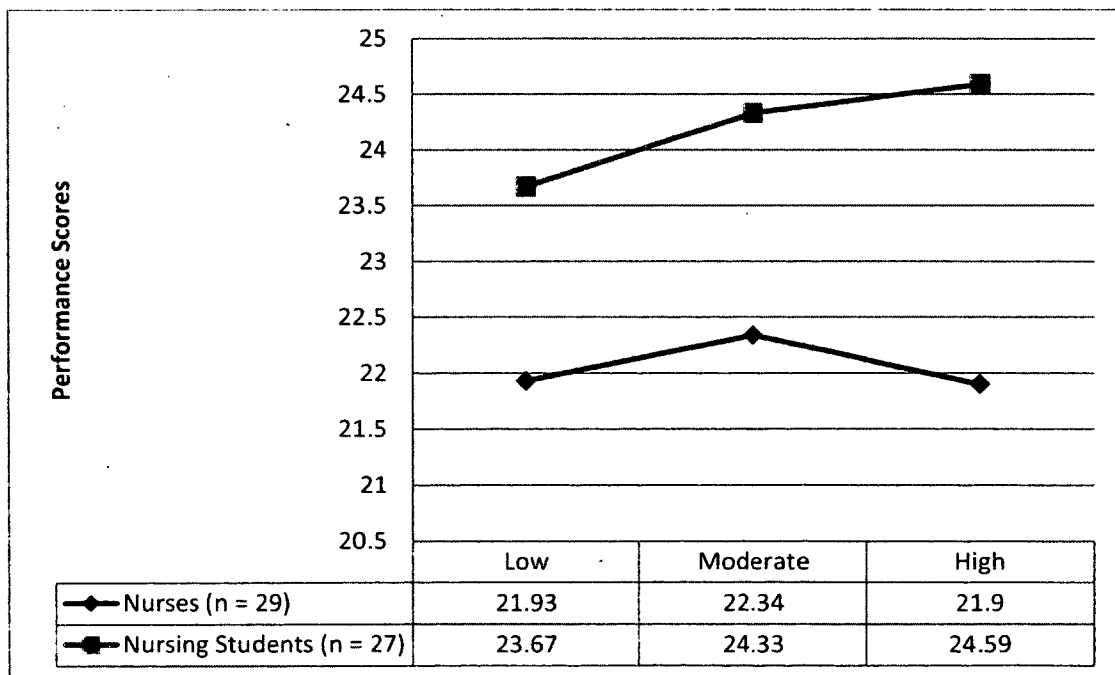


Figure 12. Mean Simulation Performance Scores by Emotion Intensity

Research Question 2: Perception of the Animated Agents Persona

An independent sample t-test was conducted to evaluate if experienced nurses had a more positive perception of the animated agents presented in the simulated environment than nursing students. The test failed to reveal a statistically significant difference between experienced nurses ($M = 4.17$, $SD = .381$) and nursing students ($M = 4.08$, $SD = .282$), $t(46) = .861$, $p = .394$, $\alpha = .05$. Both groups, experienced nurses and nursing students, rated the animated agents as credible, human-like, and engaging facilitators of learning (as shown in Figure 13).

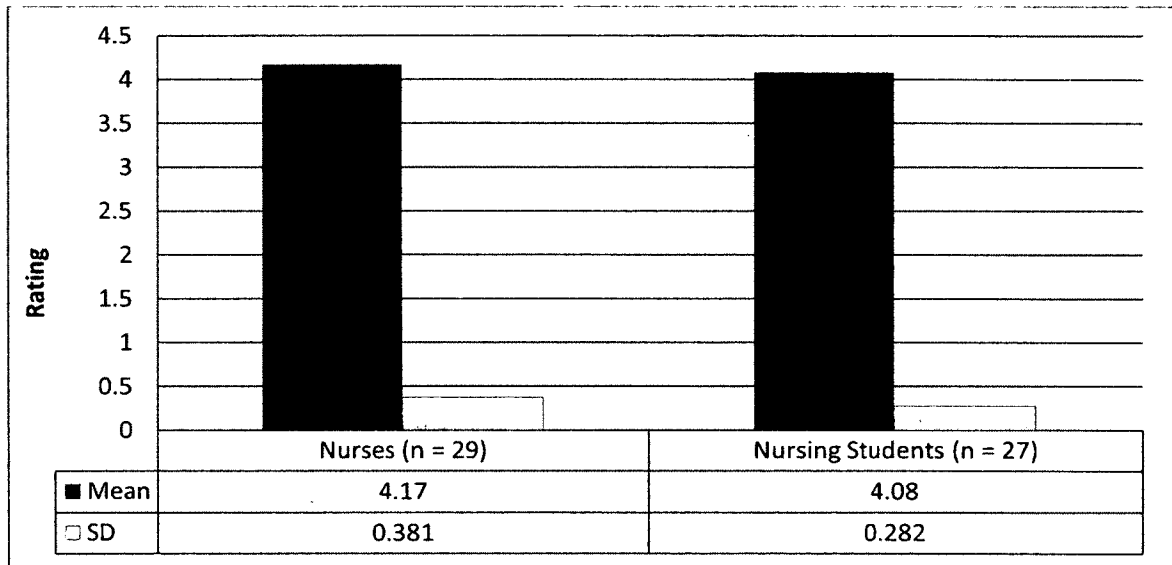


Figure 13. Perception of the Animated Agent Persona

CHAPTER V

DISCUSSION AND CONCLUSIONS

The purpose of this research was to investigate the effects of emotionally responsive agents in simulation-based training. Specifically, this research assessed how emotive, animated agents affect the visual attention, emotional responses, and performance of individuals interacting with a computer-based simulated environment. Prior research on animated agents in computer-mediated environments has focused on the learning outcomes as a result of interactions with animated agents (Adcock et al., 2006; R. K. Atkinson, 2002; Baylor, 2002; Moreno et al., 2000). However, only a few studies have truly explored the emotional behaviors that can help create a sense of drama to enrich the role of animated agents (Gratch et al., 2002; Rickel et al., 2002).

Implications of this Study

Expanding upon recent research on the importance of emotion in animated agents, (Bickmore, 2004; Bickmore & Picard, 2004; Kim et al., 2007; Veletsianos, 2009) this dissertation research investigated the effect of three animated agents with different emotion intensity levels (i.e., low, moderate, high). Many have argued that based on psychological theories of emotion (Gratch et al., 2002; Rickel et al., 2002), animated agents with emotive qualities can leverage the learners' natural tendencies of humanness. However, the results of this research did not indicate a relationship between the three animated agents with varying levels of emotion intensity and the participants' visual attention, emotional response, and simulation performance scores.

One explanation for the lack of significant results between levels of emotion intensity is that the three animated agents portrayed perceptually similar emotive

properties; therefore, participants did not perceive the animated agents differently. The results of the agent persona instrument provide evidence that the participants had a positive perception of the three animated agents and viewed them as facilitators of learning, credible, human-like, and engaging.

Another purpose of this research was to investigate how visual attention, emotional response, performance, and perception outcomes vary depending on the level of expertise of the participant interacting with emotionally responsive agents in simulation-based training. It was expected that experienced nurses would accrue greater visual attention on the task relevant information than novices. According to the information-reduction theory, experienced participants optimize the amount of processed information by actively focusing on task-relevant areas of the screen and neglecting task-redundant areas (Gegenfurtner et al., 2011). The results of this research indicated that both experienced nurses and nursing students focused more visual attention time on the body of the animated agent. This implies that the participants (experienced nurses and nursing students) perceived the body of the animated agent as task-relevant information needed to successfully complete the pain assessment interview of the patients. Perhaps, the experienced nurses and nursing students visually fixated on the body of the agent as a guiding cue needed to assess the patients' pain level.

Additionally, the results of the visual attention measures relate to the influence of emotional stimuli on visual processes (Hunt, 2007; Shields et al., 2012). According to Hunt (2007), emotion can guide visual attention and it may be more difficult to ignore emotional stimuli relative to areas of the screen where the stimuli are emotionally neutral.

The results suggest that the expressive body language was a focal point of emotional state decoding as well as emotion strength and intensity.

Regarding the emotional responses of the participants, it was hypothesized that experienced nurses would portray more neutral expression compared to nursing students. Previous studies have used the facial expression coding system to detect emotional responses from the participants' faces after interacting with an animated agent (Harley et al., 2012; Terzis et al., 2012), these empirical studies did not compare emotional responses between novices versus experienced participants. The present study yields a very different portrait of the emotional responses between participants by providing a comparison involving nursing students and experienced nurses.

The results of this research indicated that nursing students showed a significant number of neutral facial expressions of emotions during their interaction with the animated agents. On the other hand, experienced nurses did not guard their emotions from the simulated patients (the animated agents). Experienced nurses showed significant facial expression of disgust during the pain assessment interview. This result supports the role of emotion in nursing expertise (Benner, 1984; Gobet & Chassy, 2008). According to Gobet and Chassy (2008) expert intuition in nursing is colored by emotions. The TempT theory of nursing expertise, presented by Gobet and Chassy (2008), proposes that chunks and templates get associated to emotional responses during the activities taking place in the practice and study of nursing (Gobet & Chassy, 2008). When a chunk or a template is retrieved from long-term memory, it activates one or several emotional responses (Gobet & Chassy, 2008). Benner's theory of skills acquisition in nursing also emphasizes the importance of being emotionally involved as part of the development of nursing intuition

(Benner, 1984). According to Benner (1984), advanced nurses can rely on a larger repertoire of emotional responses, which are used to amplify the nurses' perceptual cues.

It was expected that experienced nurses would achieve higher simulation performance scores compared to nursing students. This assumption was based on the expertise literature, which stated that expert performers have different thinking strategies (Ericsson & Charness, 1994; Shanteau, 1992) and use more automated thinking (Ericsson & Charness, 1994; Shanteau, 1992) whereas novices lack the ability to function as skilled decision makers (Shanteau, 1992). The results of the data analysis of the simulation performance score showed that nursing students achieved higher scores in the pain assessment and management simulation task than experienced nurses. These results do not support the hypothesis; instead the results demonstrate an expertise reversal effect (Kalyuga, 2007; Kalyuga & Renkl, 2010; Kalyuga et al., 2012).

These findings could be due, in part, to the cognitive processes already established by experienced nurses and the level of fidelity of the simulation. The experienced nurses have performed pain assessment and management procedures with real-life patients for at least three years; they have a pre-established nursing routine (Benner, 1984; Gobet & Chassy, 2008). Perhaps, the pain assessment and management practice followed by the experienced nurses in their clinical setting was not easily transferable to the simulation due to the level of fidelity (Alessi & Trollip, 2001). During the data collection appointment experienced nurses would ask if they could perform several tasks simultaneously, such as introduce themselves to the patient and wash their hands. However, the simulation did not allow participants to perform more than one task at the time; it did not allow multitasking.

A low level simulation fidelity can assist novice learners in acquiring the training and education necessary (Choi, 1997), but at the same time it can under stimulate or provide redundant information to expert learners (Kalyuga, 2007; Kalyuga & Renkl, 2010; Kalyuga et al., 2012). Prior research on the expertise reversal effect has stated that it is incorrect to assume that if some instructional material is effective with novice learners it should also works with experienced learners (Kalyuga et al., 2012). Many experimental studies have demonstrated that instructional procedures and techniques that were effective for novice learners appeared to be detrimental for experts (Kalyuga, 2007; Kalyuga et al., 2012).

Lastly, the results of the agent persona instrument showed that experienced nurses and nursing students perceived the animated agents as facilitators of learning, credible, human-like, and engaging. The findings did not show a difference between novices and experts in their attitudes towards the animated agents. Both groups of participants rated the animated agents as characters with emotion and personality. Additionally, participants agreed that the agents were expressive and entertaining. They strongly agreed that the animated agents made the training interesting, kept their attention, and helped them concentrate on the simulated environment.

The fact that the perception of the animated agent was similar between the two groups of participants may have resulted from the Agent Persona Instrument's low sensitivity to perception between novices and experienced participants. As explained by Ryu and Baylor (2005), one of the limitations which impacts the potential generalizability of the Agent Persona Instrument model is that only undergraduate students participated in the validation of the instrument. The instrument was not designed

to capture difference in perception between learners of different ages (Ryu & Baylor, 2005) or levels of expertise.

Limitations

One of the main limitations of this study is the pool of participants that were recruited for participation in this dissertation research. Although most of the experienced nurses were recruited from different clinical settings (i.e., hospitals and clinics), some of the participants were school nurses. As stated in the literature review, expert performance is domain specific (Ericsson & Charness, 1994; Ericsson et al., 1993; Ericsson & Lehmann, 1996; Shanteau, 1992). The special skills of an expert are diminished outside his/her area of expertise (Ericsson & Charness, 1994; Ericsson et al., 1993; Ericsson & Lehmann, 1996; Shanteau, 1992). The type of nurses recruited for participation may have affected the results for the experienced participants in the simulation performance task.

Conclusion

On the bases of this study alone, it is difficult to be certain that emotive, adaptive animated agents with varying levels of the emotional intensity have an effect on the learning experiences of learners. However, there was evidence that emotionally expressive agents have different effects on novices versus experienced learners. The use of emotion qualities in the human-like agents influenced the novice and experienced learners' social interactions in the computer-based simulated environment. Furthermore, the animated agents' affective behaviors represented a human-computer interaction based on a human-human metaphor.

The use of physiological measures such as eye tracking and a facial expression coding system provided insight into the learners' visual attention and emotional

responses towards the emotive animated agents. Thus far, few studies on animated agents integrated physiological measures to non-intrusively obtain data from the learners (Harley et al., 2012; Louwerse et al., 2009; Terzis et al., 2012). In this dissertation research, physiological measures provided a better understanding of how both the nursing students and the experienced nurses processed the affective behavior of the animated agents.

This research also focused on the use of simulated environments for education and training. Although the simulation was specific to the nursing context (i.e. pain assessment and management in nursing), the results inform the design and development of simulations for other fields. The findings are especially important for instructional designers because they provide insight into the effects of fidelity in the performance between novices and experts. This dissertation research, like other research efforts (Alessi, 1988; Alessi & Trollip, 2001), demonstrated that the relationship between fidelity and transfer of performance is more complex and depends on, among other things, the instructional level of the learners.

While a single empirical investigation cannot provide a sounds basis for the importance of emotionally expressive animated agents in simulated environments, this study suggest that instructional designers should consider the differences between participants with different levels of expertise when designing agent-based simulated environments.

Future Research

Further research should use additional physiological measures of cognitive processing data from the learners as they perform different tasks and social interactions

with the animated agents. Prior research suggests that for learning to occur, changes in the brain of the learner must also take place (Etnier, Whitwer, Landers, Petruzzello, & Salazar, 1996). It is thought that there is a relationship between the electrical rhythms of the brain and learning (Burks, 1957). Some researchers believe that one of the essential elements in the pursuit of effective instruction is monitoring the learner's cognitive processes during the learning process (Macaulay & Edmonds, 2004). Researchers studying learning in humans have begun to use psychophysiological measures, such as electroencephalography (EEG), to examine changes in brain activity that occur during the learning process (Etnier et al., 1996; Jausovec, 1997). Using psychophysiological methodology to measure changes in brain activity allows researchers the opportunity to make invisible thinking processes observable (Gerš & Jaušcvec, 1999).

Lastly, further research should consider a qualitative exploration that helps expand current findings and provide an insight into the participants' learning experiences and attitudes (i.e., suggestions for improvement, likes, dislikes, perception) towards the animated agents and the simulated environments. Thus far, only one qualitative investigation has been conducted on the topic of animated agents. In their research, Veletsianos and Miller (2008) examined the conversations between learners and pedagogical agents to understand the experiences of the individuals. Although the value and importance of experimental designs cannot be ignored, qualitative research may enable researchers to better understand learners' experiences and perceptions (Veletsianos & Miller, 2008).

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APPENDIX A. Emotion Intensity Rendering Validation Study

A small validation study was conducted to corroborate the emotion intensity pain rendering of an animated agent use by the researcher in the pain management 3D simulation. The emotion intensity of the rendering was controlled using body movement, verbal communication, and behaviors. The emotion intensity was modeled to coincide with specific pain scores using a Visual Analog Scale (VAS). The low emotion intensity corresponded to the pain score of three. The behaviors of the animated agents with the low emotion intensity were: neutral expression and able to talk normally (P. Atkinson et al., 2009). The moderate emotion intensity corresponded to the pain score of six. The behaviors of the animated agents with moderate emotion were: protective of affected area, less movement, and complaining of pain (P. Atkinson et al., 2009). The high emotion intensity corresponded to the pain score of nine. The behaviors of the animated agents with high emotion intensity were: restless unsettled, complains about lots of pain, and cries inconsolably (P. Atkinson et al., 2009).

The validation study took place during the development process, prior to the use of the nursing simulation. Since the simulation was available through web-based 3D software, the validation process was conducted using the Internet.

Participants:

The participants were 10 nursing professionals with experience in pain assessment and management. There were a total of 8 females and 2 males. The age distribution was as follows: one participant was in the 25 to 34 age group, one participant was in the 35 to 44 age group, five participants were in the 45 to 54 age group, and three participants were in the 55 to 64 age group. Seven of the participants described themselves as full-time

nurses and three as part-time nurses. The rank levels included: three registered nurses, five advance practice nurses, one registered nurse and pain consultant, and one graduate from a Master's of Science in nursing program.

When asked to identify the number of years in clinical experiences, nine participants stated that they had 3 years or more of clinical experience and one participant stated that he/she had 1 to 2 years of clinical experience. The same distribution was obtained when the participants were asked to identify the numbers of years they had with pain assessment and management. Nine participants described themselves as pain assessment and management experts and one participant described him/herself as a novice on pain assessment and management.

Materials:

Nine simulated patient animations with different pain intensity levels were presented through a web-based interface.

Instruments:

A survey instrument with one Likert scale item and open-ended question was used to rate the pain level portrayed by the animated agent in each animation and to explain the observed cues that lead to this rating.

Procedure:

An email was sent to the participants of the validation study. The email included: detailed instructions, a link to the animations, and a link to the survey instrument. Participants were asked to read the instructions provided in the email. Then the participants interacted with the nine simulated patient animations. Finally, the participants were asked to open the link to the survey instruments and completed the

survey items. The ratings for each animation were evaluated for the average and frequency of ratings as well as descriptions of perceived pain.

Results:

Three videos with an animated agent portraying a pain level equal to 3 (VAS) were rated by the participants (scene1, scene2, scene3). The average rating for scene1 was 6.30, for scene2 was 5.60 and for scene3 was 6.00. Additionally, participants rated three videos (scene4, scene5, scene6) in which the animated agent portrayed a pain level equal to 6 (VAS). The average rating for scene4 was 4.71, for scene5 was 5.33 and for scene6 was 6.33. Lastly, participants viewed three videos (scene7, scene8 scene9) in which the animated agent portrayed a pain level of 9 (VAS). The average rating for scene7 was 6.13, for scene8 6.13 and for scene9 was 5.89. The results indicate that none of the videos were given a very low or high pain level rating. In their majority the videos of the animations were rated as moderate pain level (emotion intensity). Some of the comments provided by the participants shed light on the results for each video animation.

Discussion:

Modifications and improvements were made to the nursing simulation based on the input from the nursing professionals that participated in the study.

APPENDIX B. Simulation Scenario

Title:

Pain Management in the Emergency Department

Target Audience:

Undergraduate nursing students and professional nurses.

Objectives:

Primary objectives:

- Correctly confirm a patient's identity.
- Apply proper nursing actions to initiate care of patient.
- Evaluate patient, including vital signs and pain assessment.
- Determine the nursing care for the patient based on assessed patient condition as well as, reported and observed pain assessment.
- Implement the appropriate pain management care in a safe manner.

Critical Path Checklist:

- Wash hands
- Sanitize hands
- Identify the patient using the ID Band
- Identify the patient using the Patient Chart
- Utilize Patient Medical Records to collect subjective data about the patient
- Obtain patient vital signs:
 - Obtain blood pressure
 - Obtain heart rate
 - Obtain respiratory rate
 - Obtain temperature
 - Obtain oxygen saturation
 - Assess pain utilizing pain scale
- Assess pain utilizing PTSQR interview
- Utilize Non-Medication Interventions:
 - Reposition patient based on pain location for comfort
 - Provide comfort measures
 - Encourage slow ease deep breathing to ease pain
- Check allergies to pain medication or specific sensitivity to other medications
- Provide dose of prescription pain medicine
- Fill Medical Administration Record

Correct Medication Treatment:

- Acetaminophen

Setting:

- Emergency Department hallway
- Patient Room

Equipment Available in Room:

- Blood pressure cuff
- Cardiac Monitor
- Sink
- Hand Sanitizer
- Thermometer
- Pulse Oximeter
- Stethoscope
- Visual Analog Pain Scale
- Bottle of Acetaminophen
- Pamphlet on the Pain Management

Documentation Forms:

- Patient Chart
- Patient Medical Records
- Medication Administration Records

Roles:

- Nurse
- Patient

Scenario Background:

It is the day shift (10:00 a.m.) and as a nurse you will provide care to Jose Rodriguez, Lin Chan, and Arthur Smith, patients who arrived to the emergency department (ED). The patients are co-workers in a business trip. They were playing a golf game earlier in the day and their golf cart flipped over. All three patients are alert and orientated to person, place, and time. Dr. Scott already assessed the patients, left medical orders, and order lab tests. The lab work has been done for the patients. This will be your first encounter with the patients. The patients are complaining of abdominal pain and adopting positions of discomfort. They also have some contusions, bruising in the forehead, and black and blue mark on shoulder from the seatbelt.

Description of Jose Rodriguez:

- Gender: Male
- Age: 45
- Race: Hispanic
- Weight: 190 pounds
- Height: 5'8"
- Behavioral pain level = 3
- Clinical pain level = 9

Description of Lin Chan

- Gender: Male
- Age: 60
- Race: Asian
- Weight: 145 pounds
- Height: 5'7"
- Behavioral pain level = 6
- Clinical pain level = 9

Description of Arthur Smith

- Gender: Male
- Age: 30
- Race: Caucasian
- Weight: 120 pounds
- Height: 5'9"
- Behavioral pain level = 9
- Clinical pain level = 9

APPENDIX C. Simulation Interaction Instructions for Participants

| | |
|--|--|
| <p>Entering the Simulation</p> <ul style="list-style-type: none"> ▪ Click on the desktop icon ▪ Enter participant ID to login ▪ Click "Start" <p>Entering a Patient Room</p> <ul style="list-style-type: none"> ▪ Click on the patient room door <p>Exiting a Patient Room</p> <ul style="list-style-type: none"> ▪ Click on the patient room door ▪ Confirmation message will pop-up on the screen ▪ Click "Exit Room" or "Stay In Room" <p>Navigation</p> <ul style="list-style-type: none"> ▪ Right click the mouse for: <ul style="list-style-type: none"> ▪ 360° degrees horizontal view ▪ 10° degrees vertical view – up ▪ 30° degrees vertical view – down <p>Selection of Instruments, Objects, and Patient</p> <ul style="list-style-type: none"> ▪ Left click the mouse to select an instrument, object in the room, or the patient <p>Selection of Menu Options</p> <ul style="list-style-type: none"> ▪ Left click the mouse to select from the menu options <p>Scoring</p> <ul style="list-style-type: none"> ▪ Points will be given for every correct action (in the correct order) towards pain assessment and management of the patient <p>Exiting the Simulation</p> <ul style="list-style-type: none"> ▪ After you visit with all three patients, a message will appear on the screen with an exit button. Click Exit. | <p>Archives</p> <p>Categories</p> <ul style="list-style-type: none"> ▪ Uncategorized <p>Meta</p> <ul style="list-style-type: none"> ▪ Register ▪ Login ▪ Entries RSS ▪ Comments RSS ▪ WordPress.com |
|--|--|

Figure 14. Simulation Interaction Instructions

APPENDIX D. Simulation Objects Handouts

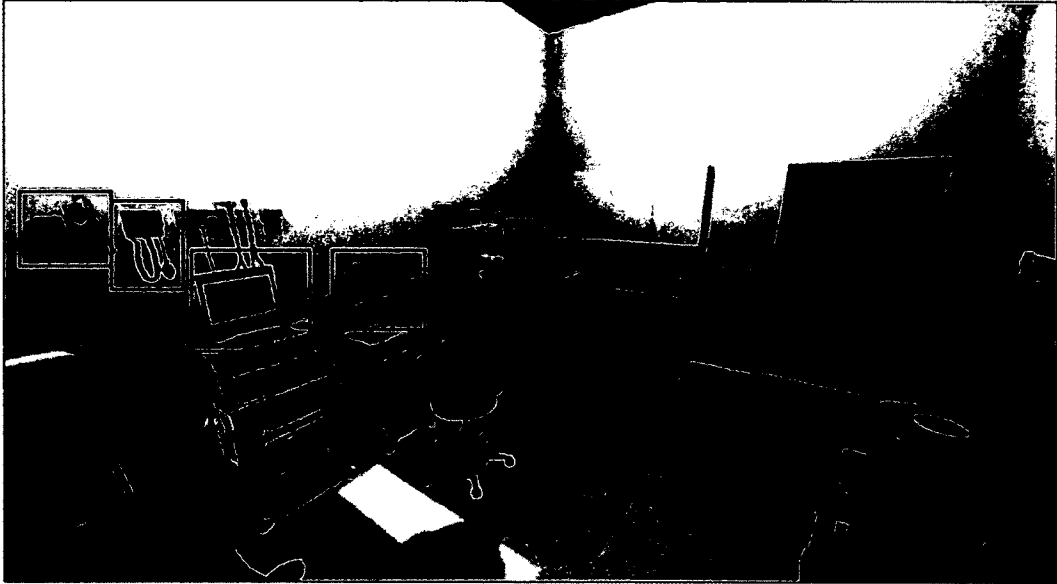
| | |
|--|-----------------------------|
|  | |
| Simulation Environment Clickable Objects | |
| Room | Computer |
| | Hand Sanitizer |
| | Medication Bottles |
| | Sink |
| | Stethoscope |
| | Blood Pressure Cuffs |
| | Phone |
| | Pulse Oximeter |
| | Thermometer |
| | Cardiac Monitor |

Figure 15. Simulation Objects Handout (Front Side)

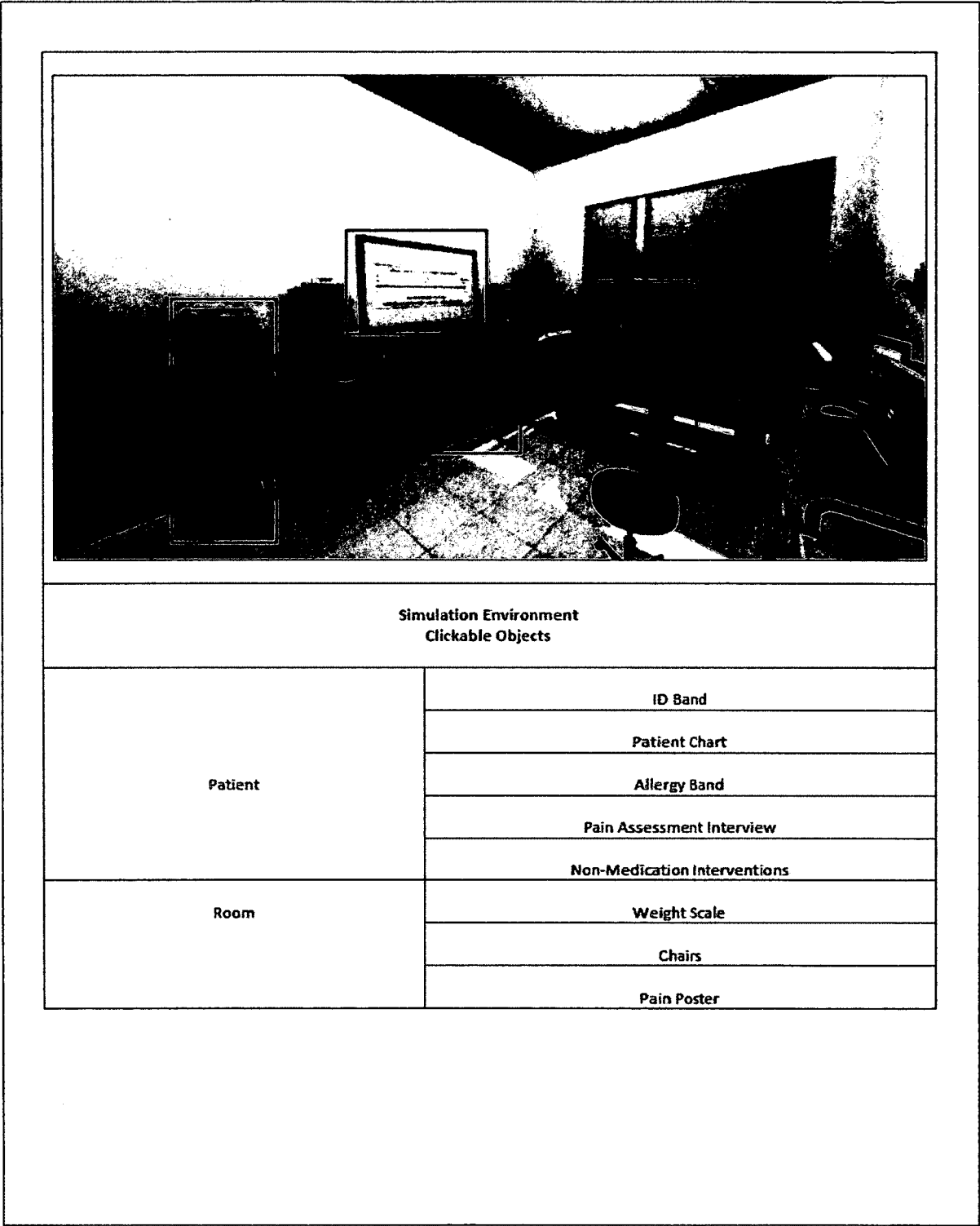


Figure 16. Simulation Objects Handout (Back Side)

APPENDIX E. Demographic Questionnaire

1. Are you a male or female?

- ☐ Male
☐ Female

2. What is your current age?

- a. 18 – 25 _____
b. 26 – 35 _____
c. 36 – 50 _____
d. 51 – 64 _____
e. 65 or older _____

3. Rate your level of experience with computers by circling one of the numbers in the range below.

| Novice | Beginner | Intermediate | Proficient | Expert |
|--------|----------|--------------|------------|--------|
| 0 | 1 | 2 | 3 | 4 |

4. About how many hours a week do you use a computer?

At home _____
At work _____

5. What do you typically use your computer for? (Check all that apply)

- ☐ Educational / Entertainment Games
☐ Internet Browsing
☐ Email
☐ Social Networking
☐ Distance Education Courses
☐ Accounting/Finance
☐ Word Processing
☐ Graphic Design
☐ Other(s): _____

6. Are you a native English speaker?

☐ Yes

☐ No. What is your native language(s)? _____

7. Are you right-handed or left-handed?

☐ Right-handed

☐ Left-handed

☐ Ambidextrous

8. Do you have any diagnosed brain or cognitive processing disorders?

☐ No

☐ Yes, Please explain _____

APPENDIX F. Expertise Questionnaire

1. Are you a nursing student?

- ☐ Yes (continue to question No. 2)
- ☐ No (continue to question No. 4)

2. What is your current college level in nursing school?

- ☐ Freshman
- ☐ Sophomore
- ☐ Junior
- ☐ Senior

3. How many courses have you completed on the topic of pain assessment and management?

- a. 0 – 2 courses
- b. 3 – 5 courses
- c. 6 or more courses

4. How many years of professional experience do you have in a clinical setting?

- a. 1 year
- b. 2 years
- c. 3 years
- d. 4 or more years

5. How many years of clinical experience do you have with pain assessment and management?

- a. 1 year
- b. 2 years
- c. 3 years
- d. 4 or more years

APPENDIX G. Knowledge and Attitudes Survey Regarding Pain

Knowledge and Attitude Survey Regarding Pain developed by Betty Ferrell, RN, PhD, FAAN and Margo McCaffery, RN, MS, FAAN, (<http://prc.coh.org>), revised 2012

True/False – Circle the correct answer.

- T F 1. Vital signs are always reliable indicators of the intensity of a patient's pain.
- T F 2. Because their nervous system is underdeveloped, children under two years of age have decreased pain sensitivity and limited memory of painful experiences.
- T F 3. Patients who can be distracted from pain usually do not have severe pain.
- T F 4. Patients may sleep in spite of severe pain.
- T F 5. Aspirin and other nonsteroidal anti-inflammatory agents are NOT effective analgesics for painful bone metastases.
- T F 6. Respiratory depression rarely occurs in patients who have been receiving stable doses of opioids over a period of months.
- T F 7. Combining analgesics that work by different mechanisms (e.g., combining an opioid with an NSAID) may result in better pain control with fewer side effects than using a single analgesic agent.
- T F 8. The usual duration of analgesia of 1-2 mg morphine IV is 4-5 hours.
- T F 9. Research shows that promethazine (Phenergan) and hydroxyzine (Vistaril) are reliable potentiators of opioid analgesics.
- T F 10. Opioids should not be used in patients with a history of substance abuse.
- T F 11. Morphine has a dose ceiling (i.e., a dose above which no greater pain relief can be obtained).
- T F 12. Elderly patients cannot tolerate opioids for pain relief.
- T F 13. Patients should be encouraged to endure as much pain as possible before using an opioid.
- T F 14. Children less than 11 years old cannot reliably report pain so nurses should rely solely on the parent's assessment of the child's pain intensity.

T F 15. Patients' spiritual beliefs may lead them to think pain and suffering are necessary.

T F 16. After an initial dose of opioid analgesic is given, subsequent doses should be adjusted in accordance with the individual patient's response.

T F 17. Giving patients sterile water by injection (placebo) is a useful test to determine if the pain is real.

T F 18. Vicodin (hydrocodone 5 mg + acetaminophen 500 mg) PO is approximately equal to 5-10 mg of morphine PO.

T F 19. If the source of the patient's pain is unknown, opioids should not be used during the pain evaluation period, as this could mask the ability to correctly diagnose the cause of pain.

T F 20. Anticonvulsant drugs such as gabapentin (Neurontin) produce optimal pain relief after a single dose.

T F 21. Benzodiazepines are not effective pain relievers unless the pain is due to muscle spasm.

T F 22. Narcotic/opioid addiction is defined as a chronic neurobiologic disease, characterized by behaviors that include one or more of the following: impaired control over drug use, compulsive use, continued use despite harm, and craving.

Multiple Choice – Place a check by the correct answer.

23. The recommended route of administration of opioid analgesics for patients with persistent cancer-related pain is _____

- a. Intravenous
- b. Intramuscular
- c. Subcutaneous
- d. Oral
- e. Rectal

24. The recommended route administration of opioid analgesics for patients with brief, severe pain of sudden onset such as trauma or postoperative pain is _____

- a. Intravenous
- b. Intramuscular
- c. Subcutaneous
- d. Oral
- e. Rectal

25. Which of the following analgesic medications is considered the drug of choice for the treatment of prolonged moderate to severe pain for cancer patients?

- a. Codeine
- b. Morphine
- c. Meperidine
- d. Tramadol

26. Which of the following IV doses of morphine administered over a 4-hour period would be equivalent to 30 mg of oral morphine given q 4 hours?

- a. Morphine 5 mg IV
- b. Morphine 10 mg IV
- c. Morphine 30 mg IV
- d. Morphine 60 mg IV

27. Analgesics for post-operative pain should initially be given

- a. Around the clock on a fixed schedule
- b. Only when the patient asks for the medication
- c. Only when the nurse determines that the patient has moderate or greater discomfort

28. A patient with persistent cancer pain has been receiving daily opioid analgesics for 2 months. Yesterday the patient was receiving morphine 200 mg/hour intravenously. Today he has been receiving 250 mg/hour intravenously. The likelihood of the patient developing clinically significant respiratory depression in the absence of new comorbidity is

- a. Less than 1%
- b. 1-10%
- c. 11-20%
- d. 21-40%
- e. > 41%

29. The most likely reason a patient with pain would request increased doses of pain medication is

- a. The patient is experiencing increased pain.
- b. The patient is experiencing increased anxiety or depression.
- c. The patient is requesting more staff attention.
- d. The patient's requests are related to addiction.

30. Which of the following is useful for treatment of cancer pain?

- a. Ibuprofen (Motrin)
- b. Hydromorphone (Dilaudid)
- c. Gabapentin (Neurontin)
- d. All of the above

31. The most accurate judge of the intensity of the patient's pain is

- a. The treating physician
- b. The patient's primary nurse
- c. The patient
- d. The pharmacist

e. The patient's spouse or family

32. Which of the following describes the best approach for cultural considerations in caring for patients in pain?

- a. There are no longer cultural influences in the U.S. due to the diversity of the population.
- b. Cultural influences can be determined by an individual's ethnicity (e.g., Asians are stoic, Italians are expressive, etc.).
- c. Patients should be individually assessed to determine cultural influences.
- d. Cultural influences can be determined by an individual's socioeconomic status (e.g., blue collar workers report more pain than white collar workers).

33. How likely is it that patients who develop pain already have an alcohol and/or drug abuse problem?

- a. < 1%
- b. 5 – 15%
- c. 25 - 50%
- d. 75 - 100%

34. The time to peak effect for morphine given IV is

- a. 15 min.
- b. 45 min.
- c. 1 hour
- d. 2 hours

35. The time to peak effect for morphine given orally is

- a. 5 min.
- b. 30 min.
- c. 1 – 2 hours
- d. 3 hours

36. Following abrupt discontinuation of an opioid, physical dependence is manifested by the following:

- a. Sweating, yawning, diarrhea and agitation with patients when the opioid is abruptly discontinued
- b. Impaired control over drug use, compulsive use, and craving
- c. The need for higher doses to achieve the same effect.
- d. A and B

Case Studies

Two patient case studies are presented. For each patient you are asked to make decisions about pain and medication. Directions: Please select one answer for each question.

37) Patient A: Andrew is 25 years old and this is his first day following abdominal surgery. As you enter his room, he smiles at you and continues talking and joking with

his visitor. Your assessment reveals the following information: BP = 120/80; HR = 80; R = 18; on a scale of 0 to 10 (0 = no pain/discomfort, 10 = worst pain/discomfort) he rates his pain as 8.

A. On the patient's record you must mark his pain on the scale below. Circle the number that represents your assessment of Andrew's pain.

| | | | | | | | | | | |
|--------------------|---|---|---|---|-----------------------|---|---|---|---|----|
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| ----- | | | | | | | | | | |
| No pain/discomfort | | | | | Worst Pain/discomfort | | | | | |

B. Your assessment, above, is made two hours after he received morphine 2 mg IV. Half hourly pain ratings following the injection ranged from 6 to 8 and he had no clinically significant respiratory depression, sedation, or other untoward side effects. He has identified 2/10 as an acceptable level of pain relief. His physician's order for analgesia is "morphine IV 1-3 mg q1h PRN pain relief." Check the action you will take at this time:

1. Administer no morphine at this time.
2. Administer morphine 1 mg IV now.
3. Administer morphine 2 mg IV now.
4. Administer morphine 3 mg IV now.

38) Patient B: Robert is 25 years old and this is his first day following abdominal surgery. As you enter his room, he is lying quietly in bed and grimaces as he turns in bed. Your assessment reveals the following information: BP = 120/80; HR = 80; R = 18; on a scale of 0 to 10 (0 = no pain/discomfort, 10 = worst pain/discomfort) he rates his pain as 8.

A. On the patient's record you must mark his pain on the scale below. Circle the number that represents your assessment of Robert's pain:

| | | | | | | | | | | |
|--------------------|---|---|---|---|-----------------------|---|---|---|---|----|
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| ----- | | | | | | | | | | |
| No pain/discomfort | | | | | Worst Pain/discomfort | | | | | |

B. Your assessment, above, is made two hours after he received morphine 2 mg IV. Half hourly pain ratings following the injection ranged from 6 to 8 and he had no clinically significant respiratory depression, sedation, or other untoward side effects. He has identified 2/10 as an acceptable level of pain relief. His physician's order for analgesia is "morphine IV 1-3 mg q1h PRN pain relief." Check the action you will take at this time:

1. Administer no morphine at this time.
2. Administer morphine 1 mg IV now.
3. Administer morphine 2 mg IV now.
4. Administer morphine 3 mg IV now.

APPENDIX H. Agent Persona Instrument

Baylor, A. & Ryu, J. (2003). The API (Agent Persona Instrument) for Assessing Pedagogical Agent Persona. In D. Lassner & C. McNaught (Eds.), *Proceedings of World Conference on Educational Multimedia, Hypermedia and Telecommunications 2003* (pp. 448-451). Chesapeake, VA: AACE.

| | Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree |
|---|----------------------|----------|---------|-------|-------------------|
| Facilitating Learning (10 items) | | | | | |
| The agent led me to think more deeply about the presentation. | 1 | 2 | 3 | 4 | 5 |
| The agent made the instruction interesting. | 1 | 2 | 3 | 4 | 5 |
| The agent encouraged me to reflect what I was learning. | 1 | 2 | 3 | 4 | 5 |
| The agent kept my attention. | 1 | 2 | 3 | 4 | 5 |
| The agent presented the material effectively. | 1 | 2 | 3 | 4 | 5 |
| The agent helped me to concentrate on the presentation. | 1 | 2 | 3 | 4 | 5 |
| The agent focused me on the relevant information. | 1 | 2 | 3 | 4 | 5 |
| The agent improved my knowledge of the content. | 1 | 2 | 3 | 4 | 5 |
| The agent was interesting. | 1 | 2 | 3 | 4 | 5 |
| The agent was enjoyable. | 1 | 2 | 3 | 4 | 5 |
| Credible (5 items) | | | | | |
| The agent was intelligent. | 1 | 2 | 3 | 4 | 5 |
| The agent was useful. | 1 | 2 | 3 | 4 | 5 |
| The agent was helpful. | 1 | 2 | 3 | 4 | 5 |
| The agent was instructor-like. | 1 | 2 | 3 | 4 | 5 |
| Human-like (5 items) | | | | | |
| The agent has a personality. | 1 | 2 | 3 | 4 | 5 |
| The agent's emotion was natural. | 1 | 2 | 3 | 4 | 5 |
| The agent was human-like. | 1 | 2 | 3 | 4 | 5 |
| The agent's movement was natural. | 1 | 2 | 3 | 4 | 5 |
| The agent showed emotion. | 1 | 2 | 3 | 4 | 5 |

Engaging (5 Items)

| | | | | | |
|-----------------------------|----------|----------|----------|----------|----------|
| The agent was expressive. | 1 | 2 | 3 | 4 | 5 |
| The agent was enthusiastic. | 1 | 2 | 3 | 4 | 5 |
| The agent was entertaining. | 1 | 2 | 3 | 4 | 5 |
| The agent was motivating. | 1 | 2 | 3 | 4 | 5 |
| The agent was friendly. | 1 | 2 | 3 | 4 | 5 |

APPENDIX I. Dissertation Consent Form for use of Photo or Video Material

PROJECT TITLE:

Training Effects of Adaptive Emotive Responses from Animated Agents in Simulated Environments

DESCRIPTION:

The researchers would also like to take photographs or videotapes of you interacting with the simulation environment during the data collection process in order to illustrate the research in teaching, presentations, and/or or publications.

CONFIDENTIALITY:

The researchers will take all steps necessary to keep information, such as name, student ID number, or other personally identifiable information, confidential. The researcher will store the video recording in digital video format in password-protected computer. The researcher will store the digital copies of the videos for one year and after the one year period the videos will be permanently deleted. You would not be identified by name in any use of the photographs or videotapes. Even if you agree to be in the study, no photographs or videotapes will be taken of you unless you specifically agree to this.

VOLUNTARY CONSENT

By signing below, you are granting to the researchers the right to use your likeness, image, appearance and performance - whether recorded on or transferred to videotape, film, slides, photographs - for presenting or publishing this research. No use of photos or video images will be made other than for professional presentations or publications. The researchers are unable to provide any monetary compensation for use of these materials. You can withdraw your voluntary consent at any time.

If you have any questions later on, then the researchers should be able to answer them:

Ginger S. Watson, Ph.D.

Phone: 757-683-3246

Enilda Romero

Phone: 757-819-2901

If at any time you feel pressured to participate, or if you have any questions about your rights or this form, then you should call Dr. George Maihafer, the current IRB chair, at 757-683-4520, or the Old Dominion University Office of Research, at 757-683-3460.

| | |
|---|-------------|
| Subject's Printed Name & Signature | Date |
|---|-------------|

APPENDIX J. Dissertation Consent Form

PROJECT TITLE:

Training Effects of Adaptive Emotive Responses from Animated Agents in Simulated Environments

INTRODUCTION

The purposes of this form are to give you information that may affect your decision whether to say YES or NO to participation in this research regarding the training effects of adaptive emotive responses from animated agent in simulation environments that will take place at Room 248 in the Child Study Center or Room 252 in the Education Building at Old Dominion University and to record the consent of those who say YES.

RESEARCHERS

Ginger S. Watson, Ph.D., Responsible Project Investigator

Associate Professor

Instructional Design & Technology Program

Department of STEM Education and Professional Studies

Darden College of Education & Virginia Modeling, Analysis & Simulation Center

Old Dominion University

Enilda J. Romero, M.S.

Doctoral Candidate

Instructional Design and Technology Program

Department of STEM Education and Professional Studies

Darden College of Education

Old Dominion University

DESCRIPTION OF RESEARCH STUDY

If you decide to participate in this study, you will join a study involving research of animated agents in a computer simulation. Specifically, this research will evaluate how adaptive animated agents affect the perception and instructional outcomes of individuals interacting with a computer simulation. If you say YES, then your participation will last for one hour at the Child Study Center, Old Dominion University. Approximately 100 individuals will be participating in this study.

EXCLUSIONARY CRITERIA

You will not be included in this study if you are 65 years or older.

RISKS AND BENEFITS

RISKS: In general, there are no risks associated with this research study. However, as with any research, there is some possibility that you may be subject to risks that have not been identified.

BENEFITS:

There are no direct benefits for participation in the study. However, your participation in the study could help you understand your current level of performance, knowledge and attitudes towards emergency department nursing care and procedures. Additionally, your participation may help us better understand the effectiveness of training in simulation environments using emotive animate agents.

COSTS AND PAYMENTS

There will be no costs for participating in this study. The researchers want your decision about participating in this study to be absolutely voluntary. Yet they recognize that your participation may pose costs such as time and effort. In order to help defray your cost you will receive \$15 gift card.

NEW INFORMATION

If the researchers find new information during this study that would reasonably change your decision about participating, then they will give it to you.

CONFIDENTIALITY

The researchers will take all steps necessary to keep private information confidential. The researcher will store information in a locked filing cabinet and personally identifiable information will be replace with an identification number prior to its processing by the research team. The results of this study may be used in reports, presentations, and publications; but the researcher will not identify you. Of course, your records may be subpoenaed by court order or inspected by government bodies with oversight authority.

WITHDRAWAL PRIVILEGE

It is OK for you to say NO. Even if you say YES now, you are free to say NO later, and walk away or withdraw from the study -- at any time.

COMPENSATION FOR ILLNESS AND INJURY

If you say YES, then your consent in this document does not waive any of your legal rights. However, in the event of injury or illness arising from this study, neither Old Dominion University nor the researchers are able to give you any money, insurance coverage, free medical care, or any other compensation for such injury. In the event that you suffer injury as a result of participation in any research project, you may contact Dr. Ginger Watson, principal investigator, at 757-683-3246 or Dr. George Maihafer the current IRB chair at 757-683-4520 at Old Dominion University, who will be glad to review the matter with you.

VOLUNTARY CONSENT

By signing this form, you are saying several things. You are saying that you have read this form or have had it read to you, that you are satisfied that you understand this form, the research study, and its risks and benefits. The researchers should have answered any questions you may have had about the research. If you have any questions later on, then the researchers should be able to answer them: Ginger S. Watson,

Ph.D. (757- 683 - 3246) or Enilda Romero (757 – 819 – 2901). If at any time you feel pressured to participate, or if you have any questions about your rights or this form, then you should call Dr. George Maihafer, the current IRB chair, at 757-683-4520, or the Old Dominion University Office of Research, at 757-683-3460. And importantly, by signing below, you are telling the researcher YES, that you agree to participate in this study. The researcher should give you a copy of this form for your records.

| | |
|---|-------------|
| Subject's Printed Name & Signature | Date |
|---|-------------|

INVESTIGATOR'S STATEMENT

I certify that I have explained to this subject the nature and purpose of this research, including benefits, risks, costs, and any experimental procedures. I have described the rights and protections afforded to human subjects and have done nothing to pressure, coerce, or falsely entice this subject into participating. I am aware of my obligations under state and federal laws, and promise compliance. I have answered the subject's questions and have encouraged him/her to ask additional questions at any time during the course of this study. I have witnessed the above signature(s) on this consent form.

| | |
|--|-------------|
| Investigator's Printed Name & Signature | Date |
|--|-------------|

APPENDIX K. MANOVA Summary – Gaze Time

Table 2

Mean Gaze Time by Emotion Intensity

| Emotion Intensity | Experienced Nurses | | | Nursing Students | | |
|-------------------|--------------------|-------|-------|------------------|-------|-------|
| | n | M | SD | n | M | SD |
| Low | 18 | 27.42 | 31.72 | 24 | 44.46 | 38.22 |
| Moderate | 18 | 20.59 | 25.31 | 24 | 42.57 | 39.32 |
| High | 18 | 28.36 | 32.22 | 24 | 51.57 | 41.93 |

Table 3

Mean Gaze Time by Areas of Interest of the Simulation

| Area of Interest | Experienced Nurses | | | Nursing Students | | |
|------------------|--------------------|-------|-------|------------------|-------|-------|
| | n | M | SD | n | M | SD |
| Body | 23 | 43.47 | 74.60 | 24 | 57.42 | 68.53 |
| Head | 23 | 3.66 | 10.24 | 24 | 28.16 | 43.23 |
| Questions | 23 | 12.66 | 19.15 | 24 | 53.03 | 60.59 |

APPENDIX L. MANOVA Summary – Emotional Responses

Table 4

MANOVA Summary - Emotion Intensity (Emotional Responses)

| Measure | Mean Squared | <i>F</i> | Sig. |
|--|--------------|----------|-------|
| Level of Expertise | | | |
| Neutral | 7802.841 | 8.739 | .004 |
| Happy | 1.621 | .789 | .377 |
| Sad | 12.793 | .056 | .814 |
| Angry | 4.880 | .435 | .511 |
| Scared | 0.58 | 0.21 | .0886 |
| Disgusted | 22.588 | 4.940 | 0.29 |
| Emotion Intensity | | | |
| Neutral | 149.184 | .167 | .846 |
| Happy | 1.884 | .917 | .404 |
| Sad | 123.456 | .539 | .585 |
| Angry | 12.528 | .117 | .332 |
| Scared | 1.430 | .517 | .598 |
| Disgusted | 1.714 | .375 | .689 |
| Level of Expertise * Emotion Intensity | | | |
| Neutral | 418.641 | .469 | .627 |
| Happy | 1.060 | .516 | .599 |
| Sad | 101.668 | .444 | .643 |
| Angry | 4.262 | .380 | .685 |
| Scared | .200 | .072 | .930 |
| Disgusted | 1.469 | .321 | .726 |

Table 5

Mean Emotional Responses by Emotion Intensity

| Emotions | Experienced Nurses | | | Nursing Students | | |
|-----------|--------------------|-------|-------|------------------|-------|-------|
| | n | M | SD | n | M | SD |
| Neutral | | | | | | |
| Low | 12 | 27.55 | 28.07 | 16 | 52.55 | 30.73 |
| Moderate | 12 | 30.89 | 22.77 | 17 | 53.34 | 32.19 |
| High | 12 | 39.43 | 30.78 | 17 | 49.92 | 31.50 |
| Happy | | | | | | |
| Low | 12 | 0.10 | 0.24 | 16 | 0.82 | 1.95 |
| Moderate | 12 | 0.18 | 0.45 | 17 | 0.16 | 0.45 |
| High | 12 | 0.62 | 2.14 | 17 | 0.75 | 1.78 |
| Sad | | | | | | |
| Low | 12 | 13.38 | 26.52 | 16 | 8.22 | 13.21 |
| Moderate | 12 | 6.52 | 8.67 | 17 | 7.37 | 8.99 |
| High | 12 | 9.34 | 18.09 | 17 | 11.30 | 11.87 |
| Angry | | | | | | |
| Low | 12 | 1.19 | 3.77 | 16 | 0.60 | 1.69 |
| Moderate | 12 | 2.21 | 7.29 | 17 | 1.01 | 2.35 |
| High | 12 | 0.10 | 0.36 | 17 | 0.45 | 1.20 |
| Scared | | | | | | |
| Low | 12 | 0.48 | 1.48 | 16 | 0.53 | 1.19 |
| Moderate | 12 | 0.76 | 1.99 | 17 | 0.98 | 1.94 |
| High | 12 | 0.52 | 1.57 | 17 | 0.40 | 1.66 |
| Disgusted | | | | | | |
| Low | 12 | 0.76 | 1.99 | 16 | 0.24 | 0.81 |
| Moderate | 12 | 1.62 | 4.43 | 17 | 0.24 | 0.99 |
| High | 12 | 1.54 | 2.18 | 17 | 0.32 | 1.32 |

APPENDIX M. Two-Way ANOVA Summary – Simulation Performance Scores

Table 6

Two-Way ANOVA Summary (Simulation Performance Scores)

| Measure | Mean Squared | <i>F</i> | Sig. |
|--|--------------|----------|------|
| Level of Expertise | 192.109 | 21.498 | .000 |
| Emotion Intensity | 4.656 | .521 | .595 |
| Level of Expertise * Emotion Intensity | 3.465 | .388 | .679 |

Table 7

Mean Simulation Performance Scores by Emotion Intensity

| Emotion Intensity | Experienced Nurses | | | Nursing Students | | |
|-------------------|--------------------|-------|------|------------------|-------|------|
| | n | M | SD | n | M | SD |
| Low | 29 | 21.93 | 2.79 | 27 | 23.67 | 2.34 |
| Moderate | 29 | 22.34 | 2.84 | 27 | 24.33 | 2.77 |
| High | 29 | 21.90 | 3.31 | 27 | 24.59 | 3.69 |

VITA

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ACADEMIC POSITIONS

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HONORS & AWARDS

- Darden College Doctoral Dissertation Fellowship, *Old Dominion University*, 2013
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- Professional Development Award, *Darden College of Education*, 2011 – 2012
- Alan Mandell Award in Instructional Design & Technology, 2011
- Gene Newman Award, Training & Education Track, *VMASC Capstone Conference*
- Graduate Student Travel Award, *Old Dominion University*, 2010
- Modeling and Simulation Graduate Assistantship, *Old Dominion University*
- Instructional Design Outstanding Graduate Student, *Emporia State University*, 2009
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GRANT FUNDING

- Romero, Enilda (Principal Investigator). 2012-2013. *Research Fellowship*: “Training effects of Adaptive Emotive Responses from Animated Agents in Simulated Environments.” **Darden College of Education** (Old Dominion University). \$22,076.
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SCHOLARLY ACTIVITIES

REFEREED CONFERENCE PROCEEDINGS

- Romero, E.J. & Watson, G. S. (2012). Recognition of emotional responses using a FaceReader system. *Proceedings of the Sixth Modeling, Simulation & Visualization Student Capstone Conference 2012*, Suffolk, VA.
- Romero, E.J. & Watson, G. S. (2011). Effects of a pedagogical agent’s emotional expressiveness on learner perceptions. *Proceedings of MODSIM World Conference & Expo 2011*, Virginia Beach, VA.

- Romero, E.J. (2011). Low versus high intensity emotion in animated pedagogical agents: A qualitative study. *Proceedings of the Fifth Modeling, Simulation & Visualization Student Capstone Conference 2011*, Suffolk, VA.
- Romero, E. J. & Watson, G. S. (2010). An initial framework for the design of an emotionally responsive animated pedagogical agent. *Proceedings of World Conference on Educational Multimedia, Hypermedia and Telecommunications*, Toronto, Canada, 2993-2997.
- Romero, E.J. & Watson, G.S. (2010). Emotion in animated pedagogical agents performing as virtual social actors. *Proceedings of the Fourth Modeling, Simulation & Visualization Student Capstone Conference 2010*, Suffolk, VA.
- Romero, E.J. & Watson, G.S. (2009). Integration of problem-based learning and simulation. *Proceedings of the Third Modeling, Simulation & Visualization Student Capstone Conference 2009*, Suffolk, VA.

REFEREED PRESENTATIONS

- Romero, E.J., Watson, G.S., Papelis, Y., García, H. & Croll, M. (2013). *A nursing simulation: Emergency department pain management*. Paper presented to the Annual Conference of the Association for Educational Communications and Technology, Anaheim, CA. (Accepted)
- Romero, E.J., Watson, G.S. & Papelis, Y. (2013). *Validation of avatar-based animations for the development of a nursing simulation*. Paper presented to the Annual Conference of the Association for Educational Communications and Technology, Anaheim, CA. (Accepted)
- Romero, E.J. (2012). *Training effects of adaptive emotive responses from animated agents in simulated environments*. ICEM Annual Graduate Student Panel Discussion in Emerging Technology at the Annual Conference of the Association for Educational Communications and Technology, Louisville, KY.
- Romero, E.J. & Watson, G.S. (2012). *Heuristics for the design of instructional simulations*. Paper presented to the Annual Conference of the Association for Educational Communications and Technology, Louisville, KY.
- Watson, G.S., Adcock, A., Robison, D. & Romero, E.J. (2012). *Design of an interactive 3D simulation-game environment for teaching physics*. Paper presented to the Annual Conference of the Association for Educational Communications and Technology, Louisville, KY.
- Romero, E.J. (2012). *The facereader: Affect recognition from facial representations*. Poster presented to the Annual Conference of the Association for Educational Communications and Technology, Louisville, KY.

- Romero, E.J. & Watson, G.S. (2011). *The effect of emotion on learning from an animated pedagogical agent*. Featured Research Paper presented at the Annual Conference of the Association for Educational Communications and Technology, Jacksonville, FL.
- Romero, E.J., Sliva, Y., Brown, J.R. & Watson, G.S. (2011). *Optics reflection and refraction: A virtual instructional simulation*. Paper presented at the Annual Conference of the Association for Educational Communications and Technology, Jacksonville, FL.
- Romero, E.J. (2011). *Learners' perceptions of an animated pedagogical agent in an interactive environment*. Paper presented at the Annual Conference of the Association for Educational Communications and Technology, Jacksonville, FL.
- Romero, E.J. & Watson, G.S. (2010). *An analysis of job ads in ID&T: Implications for ID&T programs & future professionals*. Paper presented at the Annual Conference of the Association for Educational Communications and Technology, Anaheim, CA.
- Romero, E.J. & Park, H. (2008). *Using clickers for interactive student learning*. Paper presented at the National Technology and Social Science Conference, Las Vegas, NV.

INVITED PRESENTATIONS

- Romero, E.J. (2013). *Research to Practice*. NURS 611 Research Design at Old Dominion University School of Nursing, Norfolk, VA.
- Romero, E.J. & Watson, G.S. (2012). *Heuristics for the design of instructional simulations*. Poster presented at the Human Factors and Ergonomics Society Virginia Student Conference, Norfolk, VA.
- Romero, E.J. & Watson, G.S. (2012). *The effect of an emotional animated agent on visual fixation, emotional response, and learning*. Paper presented at the Human Factors and Ergonomics Society Virginia Student Conference, Norfolk, VA.
- Romero, E.J. & Watson, G.S. (2011). *The effect of emotion on learning from an animated pedagogical agent*. Paper presented at the Old Dominion University Instructional Design & Technology Graduate Student Organization Meeting, Norfolk, VA.
- Romero, E.J. & Watson, G.S. (2011). *Animated pedagogical agents: Effect of emotion on learning*. Poster presented at the Old Dominion University Graduate Research Achievement Day (GRAD), Norfolk, VA.

AFFILIATIONS

Professional Organizations

- Association for Educational Communications and Technology
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- Iota Lambda Sigma National Society in Workforce Development
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