Professional Communication

Playing Games, Saving Lives: A Critical Analysis of Serious Games for Nursing Instruction

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Master's Research Project (MRP)

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List of Tables

List of Figures

List of Appendices

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Abstract

Used by military tacticians, political strategists, educational institutions and increasingly healthcare organizations, serious games are often defined as interactive digital games purpose-built to persuade and educate rather than strictly entertain (Zyda, 2005; Abt, 1970; Chen & Michael, 2005). Serious games offer learners the opportunity to experience subject matter in a different way than more traditional, classroom-based education. Using experiential learning theory (ELT) as defined by Kolb (1984), this Master's Research Project (MRP) examines how two serious games, *Post-Op Pediatric Clinical Simulation* and *Therapeutic Communication and Mental Health Assessment, Skills Practice: A Home Visit,* created for nursing education, were constructed. Specifically, this paper explores how healthcare educators and technologists from Toronto-based post secondary institutions designed these serious games. Based on the designers' understanding of serious games and their decisions, what key design elements were prioritized to support student learning and engagement? What design elements can be observed in these games? The analysis was conducted using qualitative content analysis of the designer's interviews and qualitative content analysis of the games. The research uncovers that interactivity and immersion were observed to be prioritized by the designers in their discussions and in the final design of the game. This emphasis on interactivity and immersion was described by the designers as being in service of delivering a "real-world" simulated set of patient encounters in acute care pediatrics and mental health assessments in *Post-Op* and *Home Visit* respectively. The game designers also made a series of design decisions that resulted in an always-on, pervasive game design which encourages pick-up-and-play game replayability and student experimentation.

Acknowledgements

Dedication

I would like to dedicate this MRP to my partner Derek Schraner whose unflappable calm, relentless intelligence, comedic timing and endless supply of video and board games inspired me to study games. This is also dedicated to my strong, feisty fierce daughter Emily Derouin who always inspires me to work harder and question *absolutely* everything.

Introduction

Used by military tacticians, political strategists, educational institutions and increasingly healthcare organizations, serious games are often defined as interactive digital games purpose-built to persuade and educate rather than strictly entertain (Zyda, 2005; Abt, 1970; Chen & Michael, 2005). Serious games offer learners the opportunity to experience subject matter in a different way than more traditional, classroom-based education. Using experiential learning theory (ELT) as defined by Kolb (1984), this Master's Research Project (MRP) examines how two serious games, *Post-Op Pediatric Clinical Simulation* and *Therapeutic Communication* and *Mental Health Assessment, Skills Practice: A Home Visit*, created for nursing education, were constructed. Specifically, this paper explores how healthcare educators and technologists from Toronto-based post secondary institutions designed these serious games. Based on the designers' understanding of serious games and their decisions, what key design elements were prioritized to support student learning and engagement? What design elements can be observed in these games? The analysis was conducted using qualitative content analysis of the designer's interviews and direct observation of the game play. Specifically, this paper will explore the how the design collaboration and decision-making of the healthcare educators and technologists from three Toronto-based post secondary institutions formed these serious games. Based on primary interviews held with the game designers and content analyses of both games, this MRP will compare the final design of these games for nursing with a conceptual framework for the

design of serious games created by educational researcher Annetta (2010).

Research Context

To understand the current context for serious game design, we must first look at how serious games are currently defined in the literature. Laamarti, Eid and Abdulmotaleb (2014) conducted a quantitative analysis of hundreds of journal articles on serious games in networking and computing academic journals between 1993 and 2013. Hainey, Connolly, Boyle, MacArthur and Boyle (2012) conducted a similar longitudinal survey, looking at academic journal articles published between 2004 and 2009, representing 17 electronic databases and a total of 18,298 papers. Both of these comprehensive literature reviews suggest that "there is no general consensus on the definition of serious games' or what particular games can be catergorised as serious" (Hainey et al. 2012, p. 203). However, a cluster of useful definitions emerged from these research studies. Citing Chen and Michael (2005), Hainey et al. (2012) suggest serious games are simply "games that do not have entertainment, enjoyment or fun as their primary purpose" (p. 203). Zyda (2005), suggests that they are "a mental contest, played with a computer in accordance with specific rules, that uses entertainment to further government or corporate training, education, health, public policy, and strategic communication objectives" (as cited Hainey et al., 2012, p. 26). Abt (1970), one of the first writers to coin the phrase serious games, defined serious games as having an "explicit and carefully thought-out educational purpose and are not intended to be played primarily for amusement" (p. 12).

Videogames and Serious Games

In the early 1970s, computer-based educational games like *Lemonade Stand* were used to teach school children about small business management, and the *Oregon Trail* game

was designed to educate history students about the plight of pioneers in the U.S. (p. 4). Since the early beginnings of serious games, more sophisticated online, interactive learning games are today being designed to include some of the engaging and even addicting aspects of commercial entertainment video games (Garris, 2002). The global commercial videogame market was worth $75-billion (U.S.) and is expected to grow to more than $90-billion U.S. ("Value of Global Videogame Market" Statistica, 2016) demonstrating the relative popularity of digital gaming worldwide. Garris et al. (2002) suggest the ability to harness the addictive nature of entertainment video games into the training and learning space is "(t)he 'holy grail' for training professionals…" (p. 442). Immersive, 3D interactive environments popular with entertainment users of games such as *Second Life,* a virtual avatar-based social networking and chat forum, and *Minecraft*, a pixel-art-based building and simulation game, are being used as educational environments for healthcare and K-12 education respectively. In healthcare, University of Wisconsin-Oshkosh College of Nursing's (UWOCON's) created a virtual public health office in *Second Life* to familiarize nursing students with public health as a possible career path (Schmidt & Stewart, 2010, p. 75). A digital serious game designed for military training and recruitment, *America's Army*, based on the Unreal Engine used to create commercial video games such as *Unreal Tournament* and *BioShock Infinite*, was distributed for free online in 2002 for Windows 1.0 and enjoyed popularity among fans of first-person shooter entertainment games. Given advancements in digital interactive technologies, the ability to replicate real-world or fantasy scenarios in a game has become increasingly possible for educators (Annetta, 2008).

Serious Games in Nursing Practice

Nursing has a long history of using patient care simulations in instruction. Over the past 40-plus years, nursing educators have taught students using a wide array of simulation methods that have involved in-person role playing, the use of anatomically correct

mannequins, task trainers or realistic models of arms, legs, pelvises or entire human bodies for specific hands-on training and/or live-action classroom games (Nehring & Lashley, 2009, p. 528). The use of live "standardized patients" or actors displaying some possible symptoms or reactions to the health issues can, according to some researchers, provide "a unique opportunity to enhance the communication skills of nursing students" (Alexander & Dearsley, 2013, p. 149). Staging these simulations can be costly in terms of professional service and space costs, and can be logistically complex to stage (Nehring & Lashley, 2010, p. 8). Laboratory simulations can require the hiring of professional standardized patients who are often "'healthy' individuals who are trained in the art of presenting medical conditions of a varying nature for the purpose of simulating a real medical environment." (Alexander & Dearsley, 2013, p. 150) These simulated encounters can require a dedicated space to allow clinical observers to watch and analyze the encounter, as well as supply supportive coaching to student participants. Computer-based, virtual simulation approaches have offered nursing instructors new ways to deliver hands-on practice options to a more widely distributed audience of users (Nehring & Lashley, 2010, p. 13).

Games & Experiential Learning Theory (ELT)

Experiential learning theory (ELT) (Kolb, 1984) suggests that learning is a process that requires the "texture and feeling of human experiences" with hands-on learning and concrete experiences as imperative parts of the learning process (p. 2). Learning, as defined by Kolb (1984), is the "process whereby knowledge is created through the transformation of experience…(and) results from the combination of grasping and transforming experience" (p. 41). Kolb and Kolb (2010) argue that the "ludic space" or the structure or system that enables the player to engage in the game play gives learners a safe and effective space in which to learn (p. 27). Kolb and Kolb (2010) point to the affordances of games in helping create a "learning spiral" of concrete experience (CE) and abstract conceptualization (p. 27). Kolb and

Kolb (2010) state: "When a CE is enriched by reflection, given meaning by thinking and transformed by action, the new experience created becomes richer, broader, and deeper" (p. 27). The potential emotional, cognitive and even physical impact of games applies to the Kolb (1984) ELT notion of integrative nature of learning, engaging all aspects of the learner "thinking, feeling, perceiving and behaving" (p. 31). Kolb and Kolb (2010) suggest that game play "exemplifies one of the highest forms of experiential learning..." (p. 47). Banfield and Wilkinson (2014) called gamification and serious games an"ELT pedagogy" (p. 292).

An ELT-conceptualized learning process maps to a gaming cycle, through the gamer testing and trying on new approaches, and developing knowledge through the experiences in the game (Banfield & Wilkinson, 2014, p. 291). To take this further, players can engage in virtual, concrete experience (CE), reflective observation (RO), abstract conceptualization (AC) and active experimentation (AE) within a game. An example of this might be demonstrated by a game player attempting to slay a dragon in a virtual world. The first attempt to kill the high-powered dragon with a destructive fireball spell fails, a moment of concrete experience (CE). In this failure, the player notices that the fire-breathing dragon is immune to fire spells having suffered no damage or loss of hit points, reflective observation (RO). The player wonders if using a poison-tipped arrow might yield better results as it worked with earlier, less powerful reptilian creatures in the past, a moment of abstract conceptualization (AC). The player equips the quiver and bow, and applies the poison. With the first shot, the player sees the impact the poison arrows has on the boss dragon and recalibrates as needed, combining it with a frost spell. This is a moment of active experimentation (AE). This recalls Kolb's (1984) discussion of knowledge creation as being a "transformation process" rather than being an "entity to be acquired or transmitted" (p. 38). The use of serious games in pedagogy speaks as possible, optimal learning environment offering experiential learning as per Banfield and Wilkinson (2014). ELT is often used as a

theoretical justification for the use and effectiveness of serious games in K-12, higher education and adult learning environments. Crookall (2014) noted that the combination of serious games, and the post-game discussion and debrief process "fit well with Dave Kolb's idea of spirals in the experiential learning cycle" (p. 420). The virtual hands-on experience, and real-world replication attempted in some serious games can make ELT a valuable lens with which to look at the design and structure of serious games. Can ELT help us to understand how the design team prioritized and decided upon which design elements were included in the final design?

Why Serious Games?

Educational researchers Garris et al. (2002) point to the ELT of Kolb (1984) as a possible reason that serious games offer an effective way for learners to experience content and achieve learning objectives. Serious games can provide the learners with the room to experience content, experiment with options, apply and combine information to solve in-game challenges. Educational researchers Reigeluth and Myers (2017) suggest that digital serious games give educators and learners the unique ability to "capitalize on the relationship between action and cognition (learning by doing)..." (p. 211-12). Serious games allow learners to learn at their own pace, in a self-guided way, exercising the self-regulated learning (SRL) (Reigeluth, 2017, p. 264-265). Reigeluth (2017) argues that SRL is correlated to "higher learning outcomes" because it allows learners to explore information through practice and experiential exploration" (p. 264-265). Annetta states that serious educational games (SEGs) can recreate "a lifelike experience to problem-based learning that cannot be replicated in the traditional classroom" and in this life-like complexity, SEGs can "influence more long-term memory channels" (p. 110).

How Do Games Engage?

There is a limitation inherent in serious games according to some researchers. Garris

et. al (2002) raises the question: when a game is "assigned" as a part of course does it cease to feel like a game or "...play is free and voluntary, nonproductive, and separate from the real world?" (p. 459) The literature provides some answers to the problem of keeping serious games engaging despite their service to defined learning objectives. Research has been conducted into the design and instructional elements required to make both pedagogically effective and engaging serious games. While consensus in support of a proven formula has not been achieved, researchers such as Annetta (2010), Garris et al. (2002), Reigeluth and Myers (2017) and Balan, Moldoveanu, Moldoveanu, & Morar (2016) have created frameworks based on literature reviews and empirical testing.

Annetta's (2010) framework is based on six necessary core design elements for effective serious game design. These elements are identity, immersion, interactivity, increased complexity, informed teaching and instructional environment. Based on Annetta's own experience making serious games and empirically tested elements of effective design, this design framework is based on a series of metaprinciples that include imperatives to "make thinking visible" and promote "autonomous learning" (p. 105). Central to these metaprinciples is the idea that knowledge is gained not merely by the presentation of data but rather by giving the learner a simulated experience. Annetta's (2010) first four components of identity, immersion, interactivity and increased complexity are considered to be essential to effective serious game design (p. 107). The final two I's speak to the complete learning experience, with the serious games supported by informed instruction and instructional environment. According to Annetta (2010), informed instruction refers specifically the addition of skilled teachers who can help support and troubleshoot the in-game experience, and manage the "heterogenous mix of student ability" (p. 109). The category of instructional environment refers to all of the factors that support learning from the physical space to the

virtual experience, including the supporting materials, fellow students and supplemental readings.

Serious Games Design Frameworks

Annetta's (2010) six I's find support from other researchers based on a comparative review of other design frameworks.

Identity. Annetta (2010) suggests four elements under the broader definition of identity. These elements include being a "unique individual in the environment", "avatar creation", development of "personal relationships" and feeling a "part of politics and projects" of the simulated world (p. 106). The notion of being a unique individual negotiating social relationships, developing personal relationships and being a part of the environment's "politics" were all elements tied to identity (p. 106). In the Annetta (2010) definition of identity, there is some consensus to be found in the literature particularly in support of its relative importance in serious games (Garris et al., 2002). However some nuances exist in the role identity plays in serious games and how it is executed. Identity is suggested by Garris et al. (2002) to be often tied with the category of fantasy. Based on the Garris et al. (2002) literature review of key serious game elements, the concept of identity was bound up in the notion that a player was 'trying on' another persona in the experience of the game, stating, "(a) game requires the user to adopt various roles and identify with a fictional person or role." (p. 448).

There is literature to suggest that the ability to play in the guise of another persona frees players to "experiment" and expand their perspectives and in-game strategies to solve in-game problems (Daniau, 2016, p. 427). "By allowing the participant to play a character substantially different from his own nature, the risk of acting evasively due to fear of being judged or reacting improperly ...or to the perceived expectations of the instructor, is reduced." (p. 427) Identity, the player persona in-game, is a consistent key element of serious game

8

design throughout the frameworks. Identity is a way to give the player a sense that she or he has proverbial 'skin' in the game. When the action is happening to a player surrogate, there has been an observed and empirically tested relationship to increased learner engagement (Annetta, 2008). Annetta (2010) discusses identity more as the opportunity in game to create a personalized avatar which is not coupled necessarily with fantasy in Garris et al. (2002). In this, Annetta (2010) offers more flexibility for serious game creators to fashion more commonplace "real-world" player characters. This could give players the ability to experience more routine, real-life simulation scenarios that approximate perhaps a more mundane reality.

  Immersion. Immersion was broken down by Annetta (2010) into four main characteristics that included clear goals, immediate feedback, control over game play and a sense of presence (p. 107). Immersion is often, as in Annetta (2010), tied with a sense of flow, as defined by psychologist Mihály Csíkszentmihályi (1990). It is a state when a sense of time and self disappears through complete immersion in a "microworld" or simulated reality (as cited by Garris et al, 2002, p. 452). This state of flow further requires the game to provide fast feedback, and present attainable goals, the player must constantly feel that the game, even as it increases in difficulty, is something that can be mastered (Annetta, 2010; Balen et al., 2016; Garris et al, 2002). Poor game design, repetitive game play, awkward structures can break immersion and disengage players (Balan et al., 2016, p. 334). The immediacy of feedback is also core to immersion, to keep the player "in" the game (p. 107). For Annetta (2010), the idea of clear in-game controls allowed the player to clearly engage with the game's objectives and avoid "unnecessary cognitive processing" needed to struggle with obtuse commands (p. 107). Garris et al. (2002) aligns with Annetta (2010) in the idea that immersion is bound up with a player's ability to involve herself or himself in the task without game controls getting in the way of the ability to "control or manipulate the

environment" in a way that is "immediate and natural" (p. 453). Several studies suggest that a serious game's ability to teach and be enjoyed is correlated to the player's ability to control and master in-game challenges (Iten & Petko, 2016; Strzalkowski & Symborski, 2017). As well, careful consideration must be paid to not making too many demands on the cognitive load of the learner. Only that which is directly "germane" to the learning objectives should be retained in a serious game (Iten & Petko, 2016, p. 152). Other empirical research suggests rigorous playtesting and ongoing revisions in support of usability ensures increased player acceptance. "There is no room for extraneous content that could distract players' focus on learning." (Strzalkowski & Symborski, 2017, p. 294). Pilke (2004) conducted a series of primary interviews with technology users and was able to identify that 'flow' or deep immersion was reported by participants when they had a sense of "being able to accomplish what one set out to do, having control of the situation" (p. 351). The more a player can feel they are part of the game, "present" in the simulated game world, the more immersive the game will be for the player (Annetta, 2010, p. 107).

Interactivity. The Garris et al. (2002) and Balen et al. (2016) frameworks touch on the same key idea present in Annetta (2010), that interactivity in games must map to the real-life flow and dynamics of communication, the more fidelity to real-world experiences in their variety, complexity and even unexpectedness, the more engaging a game experience can be. Interactions within the game environment, with inanimate objects, with non-playable characters (NPCs), even with learning content, is often cited as one of the key elements that drive interest in games. For Annetta (2010), interactivity was comprised of four characteristics of social interaction, verbal cues, both written and spoken, visual cues including nonverbal, body languages, gestures, and visual and auditory stimuli (p. 108). Game interactivity, according to Annetta (2010), can "allow players to be social communicators" (p. 108). The ability to engage in virtual interactions can be a compelling

experience for gamers (Balen et al. 2016). As in human interactions such as conversations, the action and reaction is often instant, and responses can be filled with both explicit and implicit information. Annetta (2010) ties immediate social feedback to a "psychological closeness" a player might feel toward a game experience (p. 108). Annetta (2010) also links use of "ambient music or noise to temp" or constantly ready the (the learner's) auditory channel for important sound clues and cues (p. 108). In this definition, Annetta (2010) finds some agreement from Garris et al. (2002), Balen et al. (2016) and Reigeluth et al. (2017). Garris et al. (2002) cites Thornton and Cleveland (1990) in saying that interactivity is the "essential aspect" of any game (p. 446).

Interactivity, as defined by Annetta (2010), is linked to the Balen et al. (2016) discussion of social "feedback" in game interactions (p. 336). Reigeluth et al. (2017) discusses the concept of "authenticity" of the game scenario, with clear roles, logical actions and reactions, and a high "fidelity" of "visual, audio, tactile, and movement elements of the game are portrayed" (p. 215). Finally, interactivity in both Annetta (2010) and Garris et al. (2002) is tied to the game's richness of sensory input, sound design and visual world created by the game makers (p. 454). The frameworks all touch on the same key idea, that interactivity in games must map to the real-life flow and dynamics of communication, the more fidelity to real-world experiences in their variety, complexity and even unexpectedness, the more engaging a game experience can be.

Increased complexity. Increased complexity was broken down by Annetta (2010) into the four subcategories of multiple game levels: aspects of competition, clear and/or explicit rules and rewards for achievement, including points, trophies, etc. Increased complexity is the concept that Annetta ties to "classic educational psychology" of scaffolding (p. 108). Going so far as to unequivocally state that "good games have multiple levels" Annetta (2010) suggests that game play offers the ability to apply previously-attained

knowledge to progressively more challenging problems to hook the user (p. 108). The gamer's ability to crawl, walk and then run through a game experience, beginning with a tutorial, and progressively through more challenging levels, allows them to feel a sense of mastery. Although, as Balen et al. (2016) points out, there is a fine balancing act to be walked by designers who strive to give users the experience of "pleasurable frustration" as envisioned by Gee (2004) and a game simply being frustrating to the player, presenting unattainable objectives and insurmountable challenges. Garris et al. (2002) captures the concept of increased complexity in the category of "challenge" (p. 450). Challenges are offered to the player through the expression of clearly specified goals however, the game should not provide a too-obvious pathway toward attaining those goals. Garris et al. (2002) suggests there should be a level of "informational ambiguity" within games to help players to enjoy the satisfaction of unlocking the mystery.

Reigeluth et al. (2017) discuss the concept of in-game or outside-the-game scaffolding and instructional support referring to this concept as *diegetic* or *nondiegetic* scaffolding (p. 216). The game itself can help the player progress with diegetic or in-game scaffolding and support. In non-diegetic approaches, an instructor can provide the player with additional resources and coaching if the player is struggling. Annetta's (2010) increased complexity definition captures the unique nature of serious games, which offers a challenge, a sense of competition and a promised set of rewards. Much like traditional lesson planning, a serious game designer must consider the learning objectives, which skills are needed along the way and when it is best to introduce new concepts (Annetta, 2010, p. 232). With increased complexity, the gamer is spurred on by achievements and rewards that can be tantalizingly out of reach, but are perceived by the learner to be attainable after the accumulation of enough experience to reach her or his learning goals.

Informed Instruction. Annetta (2010) allows for the reality that, in some cases, serious educational games (SEGs) are delivered via distance education without a teacher to synchronously mediate the content and support the learner (p. 109). However, Annetta (2010) notes there must be a mechanism to monitor and analyze student performance in the game. Support for the learner and monitoring in support of the effectiveness of the game throughout the learning process are required. An informed instructor available synchronously or asynchronously online, can assist students through the game play, allowing users who might be at differing levels of competency both in terms of knowledge or digital literacy to receive coaching. With informed instruction, students can relive the experience of the game, debrief, discuss and ask additional questions. Annetta (2010) argues this can bolster the learning from the game (p. 108). The debrief and discussion of the serious game experience is an important element of the full serious game experience. Annetta's (2010) addition of these concepts ties in the research of Lean, Moizer and Newbery's (2014) discussion of the blended learning model. By allowing in-class discussions of computer simulated games, students can engage in active learning opportunities (Lean et. al. 2014, p. 213).

Garris et al. (2002) call back to Dewey (1938) noting that experiential learning must be supported by "appropriate learner support." In this, Garris et al. recalls the Dewey (1938) dictum "experience plus reflection equals learning." (p. 455) Garris et al. (2002) discusses the importance of serious game discussion, or debriefing, citing Crookall (1995) in stating that it might be "the most critical part of the simulation/gaming experience" (p. 454). Debriefing allows instructors to bridge the gap between the game experience and the real world (Garris et al., 2002, p. 454). This notion ties in with research by Lean et al. (2014). Lean et al. (2014) investigated the efficacy of the blended learning model, allowing in-class discussions of computer simulated games to provide an active learning opportunity. The potential power of a blended learning environment is echoed by an empirical study conducted by Petranek,

Corey and Black (1992) who state: "(d)uring the debriefing discussions, the student harnesses the vast information and makes sense out of these experiences by sharing his ideas and listening to other's impressions." (p. 174)

Instructional Environment. Unlike commercial videogames, learning games are designed with clear objectives in mind. Serious games are more commonly surrounded and supported by other learning materials. Annetta (2010) defines instructional environments as the context in which serious games are used and supported. In one empirical study of a successful serious games designed for young science students, Annetta (2010) states it was "not a one-time adventure for the students, but something that connected to traditional lab activities and was replayable" (p. 109). In this context, the replayability and experimentation afforded by the game can reinforce learning. Like Annetta (2010), Garris et al. (2002) discuss the importance of surrounding and contextualizing the serious game experience with additional information and background content (p. 461). Balen et al. (2016) discuss the importance of user motivation when playing a serious game, that the user must, at some level, believe that the game has relevance to achieving a larger goal, for example a training or learning. With this extrinsic motivation, the players "are interested when the game is significant to them…" (p. 336). Reigeluth et al. (2017) break down the design of the instruction space as comprised of scaffolding, adjusting, coaching and instructing (p. 225). In this, Reigeluth et al. (2017) touches upon on the informed instruction of the Annetta (2010) framework.

While there were points in common across each of the frameworks presented here, Annetta's 'I's' framework (2010), which includes identity, immersion, interactivity, increased complexity, informed instruction and instructional environment, efficiently embraced much of what was suggested by Myers and Reigeluth (2017), Balen et al. (2016) and Garris et al (2002). There is specific value in the Annetta (2010) I's framework in the

analysis of these real-world, simulation games for nursing students. The stated goal of these case study games is to provide pragmatic, real-world patient-facing experiences. Annetta (2010) decouples the requirement of fantasy and mystery as in Garris et al. (2002), and finds more common ground than critical differences with Reigeluth et al. (2017) and Balen et al (2016) in their exhaustive surveys of serious game frameworks. Based on this survey of other serious game design frameworks, Annetta (2010) six I's was found to offer the most value as an analytical tool.

Research Questions

The research context and discussions uncovered in the literature review surfaced the following specific research questions:

RQ1: What key design elements did the healthcare educators and technologists who created the games prioritize?

This question explores how the design team's decisions be understood based the concepts of identity, immersion, interactivity, increased complexity, informed instruction and instructional environment as defined by Annetta (2010).

RQ2: What design elements from Annetta's (2010) framework were included in these games?

The MRP takes an inventory of design elements in the qualitative case study to observe to what extent the case study games contain elements of identity, immersion, interactivity and increased complexity as identified in Annetta's (2010) framework.The MRP will describe the observed presence or absence of these elements.

RQ3: How does the actual design of these serious games, and the perspectives of the games' creators compare to the Annetta (2010) conceptual framework?

With this question, the MRP seeks to uncover what can be learned from the

comparison between the reality of the design process in support of the qualitative case studies and the Annetta (2010) conceptual framework. This looks at how game designers' objectives and priorities influenced the final design.

Method

The MRP answers the research questions through primary interviews conducted with the game designers and an inventory of game elements collected through direct playthroughs of the games. The MRP focuses on two games designed for post-secondary, healthcare-focused pedagogical settings. In addition to looking at the games themselves, the MRP explores the ways the designers speak about the games to uncover a sense of their design priorities. Both games were planned, written and produced by healthcare educational and technical contributors. Using Annetta (2010) as a conceptual lens, this MRP draws upon participant interviews using a qualitative analysis of the text of their interviews, and collecting an inventory of the concepts, ideas and processes of the game and a qualitative content analysis. ELT will be used as a theoretical lens to interpret the results.

Case Study

Post-Op Pediatric Clinical Simulation. *Post-Op* (2014) is an interactive movie shot through the 'eyes' of the primary care nurse Gabe Garcia. The first-person point of view (POV) puts the player into the scenes, to interact with the non-playable characters (NPCs) who make eye contact with and speak to the nurse protagonist. The NPCs respond differently based on four player-selected options or responses, A, B, C or D, that are supplied at the 17 chapter stops within the game. The player receives points as the game progresses with a possible perfect score of 1700 points or a max of 100 points per correct answer. The player's goal is to help improve the overall well-being of the post-operative child and support the

16

child's mother. The game offers opportunities to test the student nurse's ability to effectively communicate treatment steps and alleviate feelings of concern. The learning objectives of the game are to: "complete an evidence-based postoperative assessment of a pediatric patient; apply pediatric pain management care to a postoperative patient; apply therapeutic communication to facilitate family centered care and administer IV medications to a pediatric patient. ("Post-Op,", 2014, Retrieved from https://de.ryerson.ca/sg1/index.html) The game is openly available via the web and was funded through a one-time grant from a Toronto-based post secondary institution which was awarded to the design team. The game itself is delivered in HTML5 and the branching video segments are run in Flowplayer, an online video player. This technological framework means no software needs to be downloaded on the player's system and game play can happen entirely online on via a Web browser

Figure 1

Child patient in Post-Op
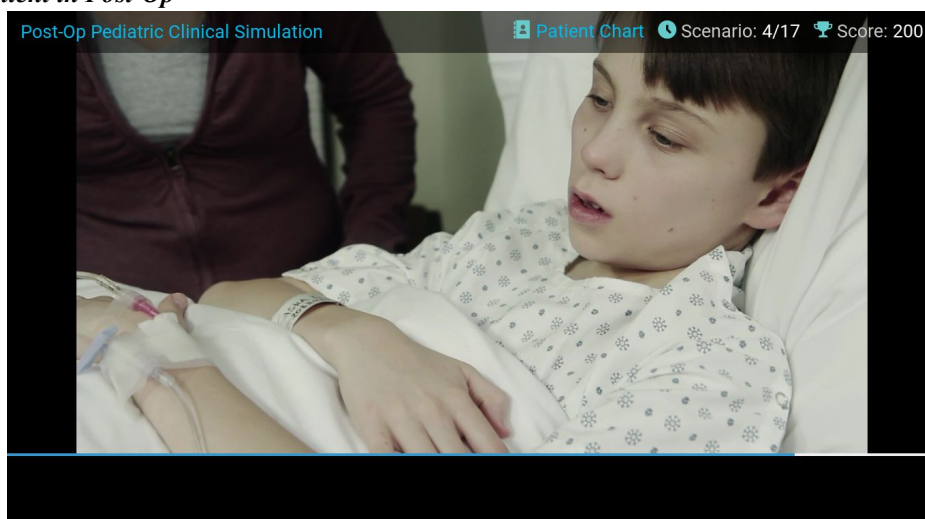
Post-Op Pediatric Clinical Simulation, (May 23, 2017), *Image of patient* [digital image]. Retrieved from https://de.ryerson.ca/sg1/simulation.html

Skills Practice: A Home Visit. *Home Visit* (2015) is designed to test the communication and negotiation skills of nursing students during a community home visit to a client. The live-action, first-person POV game takes the player through the stages of supporting a client and her family during a scheduled appointment. Designed as a branching

movie, the player is given a case file to review and then walks up the stairs of an apartment building to knock at the client's door. This begins a dramatic, emotional communication with the people who live inside. This cinematic experience features live-action performances and near real-time reactions to the player's selected dialogue options. Based on the decisions the player makes, there are branching events that allow the exploration of the consequences of his or her choices. Like *Post-Op*, the game is delivered in HTML5 using Flowplayer to run the video. This approach allows the students to play in a browser window or play via mobile device without the need to install software on a desktop, laptop, tablet or phone. This game is available 24/7 online (Retrieved from https://de.ryerson.ca/sg2/index.html) and in this way, conforms to the definition of a pervasive learning game, or a game that available in an 'always-on', unrestricted and replayable fashion as with *Post-Op*.

The game features three characters. There are two non-playable characters (NPCs) Irina Kovalik, a Russian newcomer and mother with an unseen son named Sasha, and her partner Joseph, and the player. The player experiences the game through the eyes of Ann Jones, a community health nurse. The game play is live-action with photo realistic environments and dramatic performances from the non-playable characters. The film is broken up with 13 chapter stops that prompt the player to select one of four dialogue or action options in response to what is happening with the client, Irina. The game deals with issues of domestic abuse, isolation, challenges faced by newcomers to Toronto, harm reduction and suicide prevention.

Figure 2

Client (Irina) in Home Visit
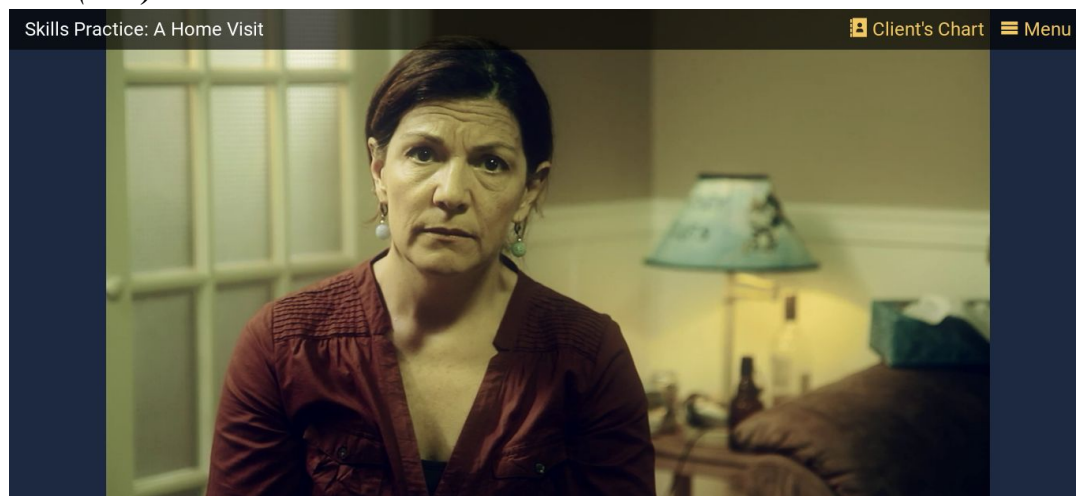
Skills Practice: A Home Visit, Therapeutic Communication and Mental Health Assessment, (Feb. 17, 2017), *Client, Irina, in her home* [digital image from game] Retrieved from https://de.ryerson.ca/sg2/game.html#/

Data Collection

Data collection was conducted through direct interviews with four game designers and an inventory of design observations made through playthroughs of the games by the principal investigator.

Design Team Interviews

Sample. The games are open learning modules available on several post secondary institution's websites. As such, the recruitment process was highly targeted to only those involved with the game development of these serious games. Six invitation e-mails were sent to members of the design team and four members responded. A series of interviews with the game designers was used to help answer the first research question, "What key design elements did the healthcare educators and technologists who created the games prioritize in the final design?" Targeted, semi-structured interviews with four nursing games' design team members were arranged via e-mail invitation. These semi-structured interviews touched on the opportunities and challenges of creating, implementing and experiencing gamified

healthcare content. The risks in participating in the interviews were outlined in a detailed informed consent form. No rewards, financial or otherwise, were promised in exchange for their participation. Anonymity and confidentiality of the interview participants were assured. The research protocol as well as the questions, call and e-mail script and consent form were fully approved by the Ryerson University Research Ethics Board (REB).

   Interview Process. Interviews were conducted with four of the key members of the design team involved with both games. Two of the interviews were with the healthcare educators who researched, planned and wrote the games. Two of the interviews were with the production team who designed and produced the interactive web-based games. Three of those interviewed were actively involved in both games, one participant was involved in the lessons learned of *Post-Op* and actively involved in *Home Visit*. The interview participants with information about their roles and the dates they were interviewed are detailed in Table 1 below. The interviews were open-ended and conversational, allowing the interviewee freedom to answer how they wished. Interviews were conducted in private meeting rooms in two cases, and in participants' offices in two cases. Participants received a hard-copy informed consent form which was explained at the beginning of the session. Participants were then asked to sign the consent forms. Each session went slightly over 60 minutes in duration. Three sessions were recorded using a Zoom H4n Pro 4-Channel recorder and one was recorded using a Samsung Galaxy 5 phone. All interview sessions were transcribed.

Table 1

Interview Targets

Pseudonym	Role	Date
Subject 1	Healthcare educator, nurse	May 25, 2017
Subject 2	Healthcare educator, nurse	May 26, 2017
Subject 3	Technologist	June 29, 2017
Subject 4	Technologist	July 10, 2017

Serious Game Design Inventory

To answer the second research question, "What design elements from Annetta's (2010) framework were included in these games?" direct, documented observations were made during the principal investigator's three playthroughs each of the two games. A playthrough involved uninterrupted end-to-end game play of each of the two games decision points until the final score or summary report was generated on the screen. Observations were logged in a structured spreadsheet that was organized by each of the six Annetta (2010) I concepts and identified characteristics of each of these design elements. Three carefully recorded playthroughs each of both the *Post-Op Pediatric Clinical Simulation* and the *Therapeutic Home and Mental Health Assessment Module, Skills Practice: A Home Visit* were conducted. The multiple playthroughs involved playing one game with many errors, one game with several errors to explore new options and one perfect game in each case.

Analysis

To answer the first research question, a qualitative analyses of the participant interview transcripts were used determine what patterns emerged (Bryman, A., Bell, E. & Teevan, J., 2012, p. 258). To answer the second research question, a qualitative content analysis of the serious games was conducted. This first involved breaking down the six Annetta (2010) I characteristics into their component ideas. For example, identity per Annetta (2010) was broken into four separate ideas: unique individual in the environment, avatar creation, personal relationships and part of politics and projects as described in this MRP's Research Context section. With the interview transcripts, the process began with the coding of the content using Annetta's (2010) I's conceptual framework to select some of the key words and phrases from the interviews that were observed to map to the characteristics

identified under each of the six Annetta 'I' concepts. The preliminary coding framework is outlined in Table 2 below.

Table 2

Preliminary Coding Framework

I Type	Definition	Characteristics
Identity	In-game persona or sense of self within the game environment	• Unique individual in the environment • Avatar creation • Personal relationships • Part of politics & projects
Immersion	Players feel they are part of the game or present in the game actions, interactions and surroundings	• Clear goals • Immediate feedback • Control over game play
Interactivity	Players' receive feedback from non-playable characters, environment and in-game challenges in the form of dialogue, visual and sound cues, etc.	• Social interactions • Verbal cues (written, spoken) • Visual cues (nonverbal) • Visual and auditory stimuli
Increased Complexity	Scaffolding or levelling within the game to allow the player to apply previous in-game learning to increasingly more difficult challenges	• Multiple levels • Competitive • Explicit rules • Rewards for achievements
Informed Instruction	Role of the instructor in supporting students in the use of the game	• In-game and classroom tools to support debrief, coaching, troubleshooting
Instructional Environment	The entire educational environment surrounding the student experience of which the serious game is a part	• Course, class, assignments, additional learning opportunities

Based on Annetta, L. (2010). The I's have it: A framework for serious educational game design. *Review of General Psychology*, 14(2), 205-242. http://dx.doi.org/10.1037/a0018985

Interview Analysis

A content analysis of the transcription of each subject's interview involved first a manual coding of all quotes or phrases that referred to ideas and keywords that pertained to or were associated with the six 'I's' and their characteristics identified with Annetta (2010). Quotes were first colour coded in Google Docs files for the six I's: identity, immersion, interactivity, increased complexity, informed instruction and instructional environment. Patterns were identified in the manually colour-coded Google Docs files in which the transcripts were securely stored. Certain word and phrases used when referring to the 'I'

elements per Annetta (2010) were collected and noted in tables. This process was utilized in an attempt to uncover a sense of the participant's emphasis and focus while speaking about the design of the games. While reviewing some of the quotes, it was recorded that certain words that might be intuitively associated with a design concept might need to be excluded. For example, the word *assessment* that might be intuitively associated with informed instruction needed to be excluded in many cases due to the fact that one of the games had the word *assessment* in its title. Based on this process, the following keyword coding framework was created as illustrated in Table 3 below.

Table 3

Keyword Coding Framework - Interviews

I Type	Definition	Coding observations key words
Identity	In-game persona or sense of self within the game environment which includes the player feeling like unique individual in the environment, avatar creation, being a part of personal relationships, part of politics & projects	Player, Ann, Gabe, first-person, point of view, POV, camera position, arms, hands, 'nurse's voice,' positioning, the 'nurse', identity, identification, "I am the nurse", gamer, person, eyes, character, logic, action, tasks, decisions, avatar, animation
Immersion	Players feel they are part of the game or present in the game actions, interactions and surroundings through the presentation of clear goals, immediate feedback, control over game play	Immersed, immersion, immerse, goals, learning objectives, learning, feedback, controls, navigation, ease-of-use, TAM, usability, acceptance, ease, easy, buy in, setting, settings
Interactivity	Players' receive feedback from non-playable characters, environment and in-game challenges in the form of dialogue, sound cues, etc. Social interactions, verbal cues (written, spoken), visual cues, nonverbal, audio cues	Irina, Joseph, Sasha, dialogue, script, interactions, speaking, visuals, expressions, emotions, performances, actors, actresses, voice, vocal, dramatic, emotional, pain, sad, "sucked in", narrative, storytelling, story, drama, anger, empathy, feel, feeling, "human stories", anger, scared, ambient, ambience, setting, settings, realistic, real, realism, authentic
Increased Complexity	Scaffolding or levelling within the game to allow the player to apply previous in-game learning to increasingly more difficult challenges, including multiple levels, competitive game play, explicit rules and rewards for achievements	Levels, levelling, scores, scorecards, leaderboards, points, competition, competitive, rewards, trophies, keeping track, replayable, replay, pervasive, 24/7, "perfect score"
Informed Instructor	Informed educators and instructors guide learners to achieve both in-game mastery and achievement of learning goals, debriefs, coaching and support to help different levels of student achievement	Instructor, instructors, teacher, professors, nursing community, faculty, coaching, teaching, discussion, debriefing, debriefs, educators

Instructional Environment	The entire in-class, blended or online learning experience including discussions, student support and additional resources	Student discussion, friends, family, other uses, grades, assignments, discussion boards, portal, modules, eLearning, learning, assign, education

Based on Annetta, L. (2010). The I's have it: A framework for serious educational game design. *Review of General Psychology*, 14(2), 205-242. http://dx.doi.org/10.1037/a0018985, Subject 1, 2, 3, 4 Personal Interviews, May 25-July 10

This manual process was then refined again using CATMA.de (Computer Assisted Textual Markup and Analysis), an open source text analysis tool created by teams at the University of Hamburg. These keywords were then run as queries in CATMA, then a full word list of all words used in the interviews was generated for each transcript, and was combed through for matches. The keywords selected in this coding process were then generated in a view that showed the word in its full context in the associated quote. Matches to selected codes were then included or excluded based on its applicability to the coding framework.

Identity Observation. As illustrated in Table 4, the following patterns were noted in how the participants spoke about the concept of identity in the games, and the frequency with which they mentioned the characteristics of identity as described by Annetta (2010). Words like player, Ann, Gabe, first-person, point of view, POV, camera position, arms, hands, 'nurse's voice,' positioning, position, the 'nurse', identity, identification, person, eyes, character, mouth, avatar, animation, greet, part, relationship logic, action, tasks and decisions were noted as patterns in the way the subjects spoke about identity in the games. These were words observed to be associated with discussions of unique player identity, avatar creation, personal relationships and part of politics and projects in the games.

Table 4

Identity Reference Frequency

Identity Mentions	Unique individual	Avatar creation	Personal relationships	Politics & projects
Reference mentions	Player, Ann, Gabe, first-person, point of view, POV, camera position, arms, hands, 'nurse's voice,' positioning, position, the	Avatar, animation	greet, part, relationship	logic, action, tasks, decisions

	'nurse', identity, identification, person, eyes, character, mouths, videographer			
Subject 1	12	2	0	1
Subject 2	14	1	1	1
Subject 3	40	0	0	8
Subject 4	19	1	1	2
Totals	**85**	**4**	**2**	**12**

Based on Annetta, L. (2010). The I's have it: A framework for serious educational game design. Review of General Psychology, 14(2), 205-242. http://dx.doi.org/10.1037/a0018985, Subject 1, 2, 3, 4 Personal Interviews, May 25-July 10

Immersion Observation. As outlined in Table 5 below, the following patterns were noted when looking at the interview participants discussions of how immersion was delivered in the games. Words like goals, learning objectives, learning, instructions, feedback, controls, navigation, ease-of-use, Technology Acceptance Model (TAM), a framework used by the designers to test usability, usability, acceptance, ease, easy, buy in and immersed, immersion were found to be closely associated with or included in discussions of immersion as defined by Annetta (2010). These were words observed to be associated most often with discussions of goals, feedback and a sense of in-game control in the games as the identified characteristics of immersion per Annetta (2010).

Table 5

Immersion Reference Frequency

Immersion Mentions	Clear goals	Immediate Feedback	Control
Keyword references	Goals, learning objectives, learning, instructions	Feedback	Immersed, immersion, immerse, controls, navigation, ease-of-use, TAM, usability, acceptance, ease, easy, buy in, difficult
Subject 1	2	9	49
Subject 2	1	2	6
Subject 3	1	1	19
Subject 4	11	18	40
Totals	**15**	**30**	**115**

Based on Annetta, L. (2010). The I's have it: A framework for serious educational game design. *Review of General Psychology,* 14(2), 205-242. http://dx.doi.org/10.1037/a0018985, Subject 1, 2, 3, 4 Personal Interviews, May 25-July 10

Interactivity Observation. As outlined in Table 6 below, the following patterns were noted when looking at the interview participants' discussions of how interactivity was executed in the games. Words and references such as Irina, Joseph, Sasha, dialogue, script, interactions, speaking, actors, actresses, dramatic, emotional, pain, sad, "sucked in", drama, anger, empathy, scared, voice, vocal, narrative, storytelling, story, visuals, expressions, emotions, performances, body language, immerse, sound, lighting, atmosphere, cinematic, cinematography, real, realism, authentic, realistic and sound effects were found to be closely associated with or included in discussions of interactivity as defined by Annetta (2010). These were words and phrases observed to be associated with discussions of design elements such as social interaction, verbal and nonverbal cues, and visual and sound stimuli in the game as the identified characteristics in Annetta (2010).

Table 6

Interactivity Reference Frequency

Interactivity Mentions	Social Interactions	Verbal cues	nonverbal	Visual & audio stimuli
Keyword references	Irina, Joseph, Sasha, dialogue, interactions, speaking, talk, actors, actresses, dramatic, emotional, pain, sad, "sucked in"drama, anger, empathy, scared, actors, actresses, patients, acting, acts, tremble	voice, vocal, narrative, storytelling, scripts, scripting, story, stories, storytelling	visuals, expressions, emotions, behaviours, bruises, body language, looks, nuance, subtle, subtleties	Sound, lighting, atmosphere, cinematic, cinematography, real, realism, realistic. virtual video, atmosphere ambient, ambience, authentic
Subject 1	36	10	4	59
Subject 2	28	24	9	9
Subject 3	3	0	6	61
Subject 4	6	5	0	32
Totals	**70**	**29**	**19**	**161**

Based on Annetta, L. (2010). The I's have it: A framework for serious educational game design. *Review of General Psychology*, 14(2), 205-242. http://dx.doi.org/10.1037/a0018985, Subject 1, 2, 3, 4 Personal Interviews, May 25-July 10

Increased Complexity Observation. As outlined in Table 7 below, the following patterns were noted when looking at the interview participants' discussions of how increased complexity was implemented in the games. Words and references such as scores, scorecards, leaderboards, points, competition, competitive, rewards, trophies, keeping track, replayable, replay, pervasive, 24/7 and "perfect score" were found to be closely associated with or included in discussions of increased complexity as defined by Annetta (2010). These were words observed to be associated with discussions of increased complexity in the games. It was observed that this was the least referred to and least discussed design element in the games. While there were discussions about scoring and elements such as leaderboards, trophies and rewards, there was limited discussion about other characteristics of increased complexity based analysis of the transcripts.

Table 7

Increased Complexity Reference Frequency

Increased Complexity Mentions	Multiple levels	Competitive	Explicit Rules	Rewards for achievements
Keyword references	Levels, levelling, level	Competitive, competition, replayable, replay, pervasive, 24/7, mistake, mistakes, perfectly	Rules, instructions	Scores, scorecards, leaderboards, points, keeping track, perfect score", rewards, trophies, summary
Subject 1	0	7	1	4
Subject 2	0	0	0	0
Subject 3	0	0	0	3
Subject 4	0	1	0	1
Totals	**0**	**8**	**1**	**8**

Based on Annetta, L. (2010). The I's have it: A framework for serious educational game design. *Review of General Psychology*, 14(2), 205-242. http://dx.doi.org/10.1037/a0018985, Subject 1, 2, 3, 4 Personal Interviews, May 25-July 10

Informed Instruction Observation. As illustrated in Table 8 below, the following patterns were noted when looking at the interview participants discussions of how informed

instruction fit in the pedagogical use of the serious games. Words and references such as instructor, instructors, teacher, professors, faculty, coaching, teaching, assessment, assessments, discussion, debriefing, debriefs and educators were found to be closely associated with or included in discussions of the role of a teacher in the use of serious games as defined by Annetta (2010).

Table 8

Informed Instruction Reference Frequency

Informed Instruction	Debriefing, coaching
Keyword references	Instructor, instructors, teacher, professors, faculty, coaching, teaching, assessments, discussion, debriefing, debriefs, educators
Subject 1	18
Subject 2	6
Subject 3	3
Subject 4	5
Totals	**32**

 Based on Annetta, L. (2010). The I's have it: A framework for serious educational game design. *Review of General Psychology*, 14(2), 205-242. http://dx.doi.org/10.1037/a0018985, Subject 1, 2, 3, 4 Personal Interviews, May 25-July 10

Instructional Environment Observation. As illustrated in Table 9 below, the following patterns were noted when looking at the interview participants discussions of the wider instructional environment that surrounds and supports these serious games. Words and references such as grades, assignments, discussion boards, portal, modules, eLearning, learning, assign, assignments, student discussion, resources, readings, community practice, friends, families, unexpected, nursing, community, university, school, schools, colleges were found to be closely associated with or included in discussions of the role of a teacher in the use of serious games as defined by Annetta (2010).

Table 9

Instructional Environment Reference Frequency

Instructional	Class, Assignments

Environment	
Keyword references	Grades, assignments, discussion boards, portal, modules, eLearning, learning, assign, assignments, student discussion, resources, readings, community practice, friends, families, unexpected, nursing, community, university, school, schools, colleges, replayable, replay, pervasive, 24/7
Subject 1	49
Subject 2	23
Subject 3	1
Subject 4	14
Totals	**87**

Based on Annetta, L. (2010). The I's have it: A framework for serious educational game design. *Review of General Psychology*, 14(2), 205-242. http://dx.doi.org/10.1037/a0018985, Subject 1, 2, 3, 4 Personal Interviews, May 25-July 10

Serious Game Inventory Data Analysis

Based on the characteristics of each Annetta 'I' type, the coding involved looking for key aspects in the game design that related to either identity, immersion, interactivity and increased complexity, informed instruction and instructional environment. Game design elements associated with these concepts are detailed in Table 10 below.

Table 10

Coding Framework - Game Design Inventory

I Type	Definition	Coding observations
Identity	In-game persona or sense of self within the game environment which includes the player being unique individual in the environment, avatar creation, being a part of personal relationships, part of politics & projects	Images of, references to player character, player names, camera position (first-person, isometric, top down?), avatar creation function present?, non-player character (NPC) awareness of player, tasks and requests, completing requirements from NPCs
Immersion	Players feel they are part of the game or present in the game actions, interactions and surroundings through the presentation of clear goals, immediate feedback, control over game play, sense of presence	Introductory game text stating objectives, response times to correct/incorrect answers, in-game movement, responsiveness of in-game control
Interactivity	Players' receive feedback from non-playable characters, environment and in-game challenges in the form of dialogue, sound cues, etc. Social interactions, verbal cues (written, spoken), visual cues (nonverbal), audio cues	Game dialogue, spoken and nonverbal (facial expressions, body language), vocal tone, text explanations and visual displays of information, clarity of visuals and sound
Increased	Scaffolding or levelling within the game to allow	Presence of a levelling system (levelling

Complexity	the player to apply previous in-game learning to increasingly more difficult challenges, including multiple levels, competitive game play, explicit rules & rewards	up), leaderboards, scorecards, time trials, statement or restatement of game rules, rewards, badges or trophies
Informed Instruction	Role of the instructor in supporting students in the use of the game including debrief, coaching, troubleshooting	Mechanisms or tools for instructors
Instructional Environment	The entire educational environment surrounding the student experience of which the serious game is a part, including student discussion, assignments, additional learning opportunities	Courses, classes, other course materials, modules and readings

Based on Annetta, L. (2010). The I's have it: A framework for serious educational game design. *Review of General Psychology*, 14(2), 205-242. http://dx.doi.org/10.1037/a0018985, *Home Visit, Post-Op*

Based on the coding framework illustrated in Table 10 above, the following observations for both games were made.

Identity Observation. As Table 11 below outlines, there were aspects of the game play that were observed to be associated with Annetta's (2010) discussions of identity including unique player identity, avatar creation, personal relationships, and part of politics and projects in the games.

Unique individual. Post-Op and *Home Visit* were observed to present a player character or in-game avatar with which to vicariously experience the game play. These player characters are "Gabe Garcia" and "Ann Jones" in *Post-Op* and *Home Visit* respectively. The player character presence in both games was signalled by the occasional appearance of the nurse avatar's hands in the video frame administering care, knocking on doors or handing out pamphlets. In *Post-Op's* opening sequence, Gabe's hands collecting paperwork and inserting pages in a binder was observed. In *Home Visit,* the player also sees the in-game avatar Ann Jones' arms and hands reaching up, and grabbing her ID from her car's rear-view mirror in the first action sequence. The use of a first-person point of view (POV) with consistent use of medium close up framing of NPCs' head and shoulders, was observed to mimic the eye-lines and personal distance between speakers one might expect in real, in-person conversations.

This first-person POV approach was observed to suggest the player's ongoing presence in the action in both games.

Avatar creation. In both games, the pre-built, live-avatars are not customizable, with no option to change appearance or voice by the player.

Personal relationships. Non-player characters make eye contact with the player character, greet and respond to both player characters, giving the player a sense of being engaged in personal relationships. For example in *Post-Op,* in the first scene, the player is greeted by an NPC who stares into the "eyes" of the player character and says, "Oh good, you are back."

Part of politics & projects. In both games, the player characters were observed to be immediately engaged in in-game projects and the social dynamics. In *Post-Op*, Gabe is ordered by a ward nurse to administer care to a post-operative patient Sasha, help the patient manage his pain and anxiety, and respond to requests and questions from Irina, his mother. In *Home Visit*, the players find themselves immediately at the start of an in-home visit, and navigating at each decision point the complex interpersonal dynamics and politics present in the small apartment occupied by Sasha and her abusive partner Joseph. The interests of Joseph and Irina are competing ones. Selecting the right option to avoid violence or emotional distress was observed to represent the politics of that situation. Similarly, there are politics in the negotiations with Sasha's mom in *Post-Op*, where her interests and that of appropriate patient care are at odds, as demonstrated in the one decision point where she asks to leave Sasha to go for a coffee after a potent pain medication is administered to Sasha. The projects in *Post-Op* and *Home Visit* are to administer care and conduct an assessment respectively.

Table 11

Identity Observation

Identity	Unique individual	Avatar creation	Personal relationships	Politics & projects
Post-Op	POV camera angle, NPCs greetings, ability to see player character's hands	Pre-built nurse "Gabe", no customizable player identity, no user name option or customization for voice or avatar appearance (different gender identities, skin colour, etc.)	NPC's awareness and recognition of player character	Completion of tasks required by NPCs, negotiation of competing interests
Home Visit	POV camera angle, player introduces herself as 'Ann', player characters arms and hands are visible	Pre-built nurse "Ann", no customizable player identity, no username option or customization	NPC's awareness of and complex reactions to player character	Completion of tasks required by NPCs, negotiation of competing interests

Annetta, L. (2010). The I's have it: A framework for serious educational game design. *Review of General Psychology*, 14(2), 205-242. http://dx.doi.org/10.1037/a0018985, *Post-Op* & *Home Visit*

Immersion Observation. As outlined in Table 12, the aspects of game play associated with goals, feedback and a sense of in-game control in the games as the identified characteristics of immersion defined by Annetta (2010) were logged.

Clear goals. Both games establish clear learning objectives on the introductory home screens of the websites where these games are posted. The learning objectives of *Post-Op* are, as referenced earlier, stated clearly on the game's introductory page. Those of *Home Visit* are, "complete an evidence-based mental health assessment with a simulated client; demonstrate knowledge of therapeutic communication and its application to crisis intervention; demonstrate knowledge of mental health assessment and its application to crisis intervention" ("Home Visit," 2015).

Immediate feedback. Both *Post-Op* and *Home-Visit* provide near-instant, split-second feedback to the player's choices.

Controls. Game controls are simple, with no requirement to move the player avatar through the in-game space. In *Post-Op*, player only needs to watch some filmed action, and then select from four video options, labelled Options A, B, C, and D across the bottom of the

screen. *Home Visit* offers response options in a large, clear yellow buttons with descriptive centred text arranged in groups of two in a landscape view across the whole screen. In both cases, the responses or options are selected with a mouse click.

Table 12

Immersion Observation

Immersion	Clear goals	Immediate feedback	Control
Post-Op	Clear statement of the game's goals on the introductory screen, exposition at the beginning of the game by the ward nurse	Split-second feedback 'smiley' faces on pop-up screens for a correct answer and 'frowny' face for an incorrect answer, detailed text explanations, negative reactions from NPCs when errors are made	Automatic movement through game space, no requirement to navigate a 3D environment, select from four video options, simple point-and-click mechanism to selecting to select response, no need to operate game camera to look around
Home Visit	Clear statement of learning objectives on the introductory screen, patient file available at all times within the player screen to refer to	Split-second feedback to correct or incorrect answers, "Not the Best response" or "Correct" with detailed explanations on text pop-up screens, negative reactions from NPCs when errors are made	No requirement to navigate a 3D environment, only need to listen to dialogue and select from four tiles which activate dialogue options, simple point-and-click mechanism to selecting the correct video or text response, no need to operate game camera to look around

Annetta, L. (2010). The I's have it: A framework for serious educational game design. *Review of General Psychology*, 14(2), 205-242. http://dx.doi.org/10.1037/a0018985, *Post-Op* & *Home Visit*

Interactivity Observation. As illustrated in Table 13 below, aspects of interactivity evidenced in the games such as social interaction, verbal and nonverbal cues, and visual and auditory stimuli in the game as the identified characteristics in Annetta (2010) are listed.

Social interaction. Social interaction is demonstrated by a focus on a question and answer format of the each games' decision point construction. In *Post-Op*, there is a brief interval of filmed action that presents the player with a question or encourages the player to make a decision, mimicking the back and forth of a social interaction or conversation. For example, the adjacency pairs of the greeting at the beginning of *Home Visit* of the nurse

announcing the reason for her visit, and the response of the apartment's occupant, mirrors the turn taking of a conversation.

      Verbal cues. In the games, verbal information is shared by NPCs' dialogue, providing background and explanation to the nurse player. The text boxes in response to decisions offer further verbal and visual information. *Post-Op* offers a variety of types of feedback, from the semiotic signifiers of the 'smiley' face for a correct answer and 'frowny' face for an incorrect answer, and a detailed explanatory text for both correct and incorrect responses. In *Home Visit*, right and wrong answers are indicated with the statements "Incorrect", "Not the Best Response" or "Correct." The text boxes are supplemented by semiotic signifiers of a green circle with a check mark, a yellow 'yield' triangle and red circle with an X in the centre for the correct answer, not the best answer and incorrect answer respectively.

      Visual/Nonverbal cues. Nonverbal cues, grimaces of pain, looks of alarm and irritation on the faces of the mother and pediatric patient help the player understand the consequences of his/her/their actions in *Post-Op*. The body language observed in *Home Visit* ranging from wringing hands, downcast eyes, to Joseph pointing a finger in the face of the player avatar conveys an impression of anxiety, shame and rage.

      Visual & audio. Both *Post-Op* and *Home Visit* offer a cinematic-quality of delivery of in-game action with clear, professional sound recording and lighting. Steady, clear, medium-focus filming allows the players to focus on the faces of the NPCs, the focal point of the action, with the background slightly blurred. There is no competing ambient noise, musical sound bed or soundtrack. The in-game dialogue was clearly audible and understandable.

Table 13

Interactivity Observation

Interactivity	Social interactions	Verbal cues (written, spoken)	Visual cues, nonverbal	Visual & audio

Post-Op	Game dialogue	NPC facial expressions, text boxes for correct/incorrect responses with professional nursing standard each decision relates to	NPC facial expressions, hand gestures, posture	High-quality video and sound production, only the most relevant information is in frame, video frame focusses on faces of the speaker with the background slightly blurred out, no distracting background noises
Home Visit	Game dialogue	NPC facial expressions, text boxes for correct/incorrect responses with prompts to find to additional information in modules	NPC facial expressions, hand gestures, posture	Cinematic video and sound production, with improved execution of the filming in this version, with compelling light and shadow effects, creating a sense of atmosphere, camera trained on the faces of the speaker with the background slightly blurred, realistic ambient sound

Based on Annetta, L. (2010). The I's have it: A framework for serious educational game design. *Review of General Psychology,* 14(2), 205-242. http://dx.doi.org/10.1037/a0018985, *Post-Op* & *Home Visit*

Increased Complexity Observation. As detailed in Table 14 below, aspects of increased complexity and its associated characteristics were outlined.

Multiple levels. Neither game was observed to feature a levelling system or a scaffolded series of levels or stages. Rather, *Post-Op* and *Home Visit* were observed to be a series of discrete challenges along the course of a single client narrative with a linear progression of consistently challenging tests of knowledge.

Competitive. Post-Op features a point-based system. There is no leaderboard, time trials or time-based challenged, or competition with other players in either game. The competition exists in the awareness of the perfect score, a high score of 1700, which is listed in the game's introductory text. *Home Visit* offers a post-game summary report of correct and

incorrect answers with no opportunity to compare results with other players in the online system.

Explicit rules. Due to the simplicity of the controls, the rules of the games are clearly stated and observed to be easy to follow. When errors are made, the player is redirected to further information to re-approach the question and try again.

Rewards. At the completion of *Post-Op*, the player is given a final numeric points-based score. *Home Visit* diverges from *Post-Op*'s points-based approach to a more qualitative approach to a final score. In this case, a detailed summary of the player's performance is supplied only at the conclusion of *Home Visit*, which is made available via a downloadable reference guide tabulating correct and incorrect responses, with more information as to why the information was correct or incorrect.

Table 14

Increased Complexity Observation

Increased Complexity	Multiple levels	Competitive	Explicit rules	Rewards
Post-Op	No multiple levels, linear game play through multiple challenges in single patient narrative	No competition in the former of player vs player or time trials, except an intrinsic motivation to improve on previous scores during subsequent replays	Simple introductory and in-game instructions, part of a wider instructional module, options to select multiple 'mini-movie' responses available via button labelled A, B, C, D	Solve 17 challenges with a possible high score of 1700, player can see score increase as the play progresses, with a maximum of 100 points per each correct response
Home Visit	No multiple levels, linear game play through multiple challenges in single patient narrative	No competition in the former of player vs player or time trials, except an intrinsic motivation to improve on previous scores during subsequent replays	Simple introductory and in-game instructions, part of a wider instructional module, simplified process for selecting answers with a tile-based system with descriptive text	Accounting of correct vs incorrect responses provided in the form of a post-play summary document the player can print or share in PDF format

Annetta, L. (2010). The I's have it: A framework for serious educational game design. *Review of General Psychology*, 14(2), 205-242. http://dx.doi.org/10.1037/a0018985, *Post-Op* & *Home Visit*

Informed Instruction Observation. While this 'I' element is difficult to inventory through in-game observations, observations were made for *Post-Op* and *Home Visit* as illustrated in Table 15 below.

Debriefing & coaching. *Home Visit* offers a downloadable or printable summary document that is designed as a full game play overview that could be shared with an instructor to support instructional debriefing, coaching and troubleshooting. *Post-Op*'s final score and post-game text could potentially be screen captured and shared as a support to a debriefing discussion or reporting to an instructor.

Table 15

Informed Instruction Observation

Informed Instruction	In-game tools for instructors including tools to support debrief, coaching, troubleshooting
Post-Op	No prompts for in-class discussion, a final game score is provided to the player that could be shared with an instructor, no downloadable summary report
Home Visit	A summary document of the student's performance in the game that can be downloaded or printed and shared with an instructor

Based on Annetta, L. (2010). The I's have it: A framework for serious educational game design. *Review of General Psychology*, 14(2), 205-242. http://dx.doi.org/10.1037/a0018985, *Post-Op* & *Home Visit*

Instructional Environment Observation. While this 'I' element is similarly difficult to inventory through in-game observations, observations were made for *Post-Op* and *Home Visit* as illustrated in Table 16 below.

Learning community & resources. *Home Visit* is integrated in a wider online set of three online, open learning modules, including *Module 1, Therapeutic Relationships and Communications Techniques*; *Module 2, Mental Status Assessment and Suicide Risk*; and *Module 3, Interpersonal Violence*. *Post-Op* was designed to offer a simulation experience as supplemental part of a classroom environment but is not surrounded by online course

material as is *Home Visit*. *Home Visit's* textual feedback to players provides prompts, at the related modules, to look for additional information if the answer is incorrect.

Table 16

Instructional Environment Observation

Instructional Environment	Additional learning materials, student discussions, modules, supplemental materials, wider learning community
Post-Op	No prompts for in-class discussion, a final game score is provided to the player that can be shared with an instructor, no downloadable summary report
Home Visit	A summary document of the student's performance in the game that can be downloaded or printed and shared with an instructor or other students

Annetta, L. (2010). The I's have it: A framework for serious educational game design. *Review of General Psychology*, 14(2), 205-242. http://dx.doi.org/10.1037/a0018985, *Post-Op & Home Visit*

Findings

RQ1: What key design elements did the healthcare educators and technologists who created the games prioritize in the final design?

Based on the analysis, immersion and interactivity were observed to be prioritized by the designers in their discussions and descriptions of the serious games. As evidenced in the analysis, interactivity and immersion were the two most referenced design elements by the design teams, with interactivity and its associated characteristics being the single-most referenced element. This emphasis on these two elements was described by the designers as being in service of delivering a "real-world" simulated set of patient encounters in acute care pediatrics and mental health assessments in *Post-Op* and *Home Visit* respectively. Based on the content analysis of the interviews, two key themes emerged. One, the designers interviewed were consistent in speaking about a focus on delivering immersive and interactive experiences. The participants placed an emphasis on speaking about quality, high-production audio and visual execution during the production of the games, in combination with delivering emotionally-charged storytelling and narrative. The second

theme is the consistent and emphasized idea of creating an always-on, online game design which encourages pick-up-and-play game replayability, and allows students to engage in practice and experimentation. Key technical decisions were made to support this focus which resulted in some tradeoffs to identity and increased complexity as defined by Annetta (2010).

Immersive Real-World Experiences. The careful focus on realistic interaction and replicating some of the affordances of a live simulation *virtually* was observed to be an integral part of the game design decision-making. Based on the coding, interactivity was the most frequently referenced design element observed in the participant interviews. According to Subject 1, the first game *Post-Op* was based on a desire to create a virtual laboratory experience at a lower cost, and make it available to a geographically distributed community of users online. Central to the in-classroom experience is human interaction, dealing with the complexities of a simulated patient encounter, according to Subject 1 and 2. In delivering a realistic experience, according to Subject 1 and 2, nurses can be motivated by and interested in client's personal stories. Of this pursuit of "realism," subject 2 said, "...playing a game like this… you want the students to connect with the client. You want it to feel real, like you are talking to a real person. And actual people have complicated stories…" This desire to appeal to nursing students drove a focus on creating complex and detailed characters in both games but particularly in *Home Visit*, according to Subject 2. Both of the healthcare educators spoke to a focus on emphasizing character development, narrative and deliberate storytelling. This decision created some tension on the team, as the technical production staff was concerned about game pacing. Of this, Subject 1 noted that nurses are motivated by interaction and personal storytelling, "they are going to be sucked in by what she (Irina in *Home Visit*) says. That is part of who we (as nurses) are…" Subject 3 said the focus on realism was particularly key to driving home the stakes of "real-world" situations and interactions with difficult topics like pediatrics and mental health, adding that in the games "you are meeting the person. This

is a real person. (It is) a chance to experience what the work of a nurse could be like." There was a focus on ensuring strong, dramatic performances from the characters in the game, ensuring there was character development, the action flowed logically and the story made sense. The focus on realism and ensuring a level of emotional impact of the games, with clear verbal and nonverbal information being shared throughout, was a guiding principle for the design.

Also linked to interactivity, Subject 3 said that creating an "atmosphere" for these virtual games was a significant focus. According to Subject 4, the care was given to staging the games in support of sound and cinematography. All of the participants spent significant time and emphasis on the topic of ensuring a high-level of "reality" in the games. Subject 3 noted that the quality of the film production was a significant focus for the production team. Lighting, sound and picture quality were emphasized during the production with Subject 3 noting that "sometimes it is a lot of sweat to prepare" the rooms for filming to ensure high-quality footage. This meant all of the crew had a clear idea of how the video shoot would unfold and this planning allowed the videographer to plan each shot carefully to ensure high-quality picture and sound to support "realism." All of these aspects, observed in the interviews, supported the sense of realism and drive for creating a "real-world" simulation according to the participants. This focus on interactivity recalls Garris et al. (2002) citing Thornton and Cleveland (1990) who note interactivity is the "essential aspect" of any game (p. 446).

Always-On, Replayable Design. The technological framework for the games in the HTML5-based approach, the use of live-action video, the open learning 24/7 availability of the always-on game allowed the designers to support another key decision and imperative: the ability to allow students to try and fail, or experiment with different approaches in the game. Each of the interview participants mentioned a desire to allow students to replay and

revisit the games with limited barriers to entry. The HTML5, Flowplayer approach noted

earlier allowed the students to play in a browser window or play via mobile device without

the need to install software on a desktop, laptop, tablet or phone. Subject 2 noted in-class

simulations with live actors playing the role of patients can have limitations in the amount of

direct experience each student in large classes can gain. These live simulations allow only

some students to actively participate. According to Subject 2: "The way the (live) sims are set

up is a group of students are all participating, some are watching." Subject 2 noted that virtual

computer simulations offered some significant advantages in terms of both distributed

broad-based access to simulated patient experiences to remote users. Subject 2 also noted the

nursing students ability to try and fail in private versus in front of an entire class can be very

appealing to first-year learners, adding: "on the positive side, you have in the virtual sim, one

person sitting, most likely by themselves, in private, doing this game." Subject 1 noted that

the replayability of the games was something that students shared was important to them.

Subject 1 reported that students had said to her: "I played it more than once because I actually

made multiple mistakes and I wanted to see what it would be like to play it perfectly once

through'."

Given both games are open learning tools, available 27/4 online, according to Subject

1, the team understood the games needed to be easy to play, with intuitive controls and clear

goals. Subject 2 noted: "If you look at the game it is not easy to use, and there are difficulties

in the student's ability to play, that defeats the purpose right there." Subject 4 noted this issue

around player controls and flow could break "immersion." Further, Subject 2 notes that the

lesson's learned in *Post-Op* usability testing changed the way *Home Visit* was designed. "(In

Post-Op) you have to stop and by the time the people have seen the fourth video, they can't

remember what was in the first one… and so that doesn't work…," said Subject 2. According

to Subject 4, the previous approach in *Post-Op* meant players "had to keep a lot of

information in their heads and it was hard to keep track" noting this was an issue they wanted to avoid with *Home Visit* as "you shouldn't need to pull out a paper and pen to jot down your impressions of the different (answer) options." Subject 4 said the results of the usability testing were positive, with users commenting that *Home Visit* "was fun, enjoyable, immersive." The process of ensuring goals for the games were clear and controls were understandable, recalls the Annetta (2010), Iten and Petko (2016) Strzalkowski and Symborski (2017) in the stripping away of complexity to facilitate immersion and attainment of learning goals.

To support replayability and user acceptance, the design team members interviewed discussed spending time and effort employing Davis (1985) Technology Acceptance Model (TAM) testing to ensure that students were able to pick up and play without need for instructor intervention or significant training in support of game controls. According to Subject 1, the design team used the TAM model for testing. TAM suggests that user acceptance of a technology is as much about the user community's willingness and motivation to use a technology as it is about a technology's features and capabilities (p. 150). Central to user acceptance, according to TAM, is perceived usefulness, the user attitude toward and the ease of use of the technology. Subject 3 and Subject 4 said that the games were tested several times with users to ensure that the students understood the in-game goals and knew how to achieve them. These usability sessions were recorded via Camtasia, the TechSmith screen recording and video capture software, to record the user interactions with the games, including players spoken-aloud remarks about the game, even the looks on the users' faces as they used the games. This effort in support of usability, the participants noted consistently, was worthwhile. Subject 1 discussed several empirical research studies conducted with users that uncovered evidence of the two games usability and effectiveness in raising nursing student feelings of self-efficacy or confidence around the pediatric and mental

health concepts taught in the games. The online and open learning format opens up the possibility for students and nurses across the world to play the games. According to Subject 1 it has given people outside of the profession exposure to the world of nursing. Subject 1 noted she has discovered that nursing students share these games with others, saying: "Oh, my friend and my sister, I had them play it."

RQ2: What design elements from Annetta's (2010) framework were included in these games?

Based on the playthrough observations, *Post-Op* and *Home Visit* demonstrate the sustained and strong presence interactivity and immersion. The games were observed to have strong narrative and supplied detailed character information that allowed the player to encounter complicated human characters. These characters were observed to respond in surprising and dramatic ways, showing a range of emotions including anger, shame, irritation and sadness. These games rely on complex and in-depth dialogue to drive forward the action. The games provide in-game information exclusively through social interaction, verbal and nonverbal cues. Immersion was enhanced by observed immediate feedback and clear goals. The game controls were observed to be simple and focused only on the game decision points, allowing the player to readily select responses to the challenges and questions with a mouse click. As earlier noted, more complex controls can break immersion. If players are struggling to learn in-game controls or games require players to navigate a 3-D game microworld, immersion can be impacted. Particularly in *Home Visit,* the player's ability to make decisions by selecting from four tiles and by eliminating the video options found in *Post-Op*, further enhanced the immersion observed in both games. Overall, simple navigation and in-game controls ensure the players able to focus on the story and the learning objectives. As such, interactivity and immersion as defined by Annetta (2010) were observed in both games.

Identity as defined by Annetta (2010) was present but lacked one of the characteristics, that of avatar personalization or customization. However, the first-person perspective and the responses from NPCs to the player character was observed to support the presence of identity. This approach in both games supported the observed characteristics of being an unique individual in the environment, having personal relationships and being a part of the politics and projects of the game world. The increased complexity characteristic of competition was present in a very limited way in *Post-Op* in its ability to count points for non-diegetic or outside of the game comparison with fellow players. Similarly, *Home Visit* offered the ability to download a summary report to assist with post-game discussion and review. While the final two 'I's' informed instructor and instructional environment can not be commented on extensively based on the game design inventory analysis, both games are integrated in wider educational contexts. *Post-Op* was designed to be incorporated into nursing courses either online or in the classroom according to the game's introductory text. In the case of *Home Visit*, it is a part of the *Therapeutic Communication and Mental Health Assessment* open learning module. These findings are consistent with the emergent themes revealed in the findings of the designer interviews, that of the prioritization of delivering immersive and interactive experiences, offering a pervasive, pick-up-and-play game replayability that affords students an opportunity to experiment.

RQ3: How does the actual design of these serious games, and the perspectives of the games' creators compare to the Annetta (2010) conceptual framework?

There were key points where the game designers and the games designs diverged from the Annetta's (2010) framework. Somewhat emphasized in the interviews and the game design was the concept of identity. There was an expressed focus on providing students with a sense of identity in the game, by filming in a first-person POV, showing the player avatar interacting 'hands-on' within the virtual world. The designers noted the first-person

perspective in the design was designed to help the player understand they were "the nurse." Subject 1 noted that filming was from the perspective of "the eyes of the nurse." Subject 3 noted that, based on research into other serious games, the production team elected to use a first-person POV to simulate that the character is participating in the game action. Subject 3 noted the games were inspired by the first-person POV in *Choose A Different Ending,* a violence prevention game created by the Metropolitan Police Force in London. Subject 4 noted this approach supported a sense of the player "being there" in the action, adding this underlined that "the person who is playing the game is the nurse." Diverging from the Annetta (2010) definition of identity, there is no function within the games to create a customized avatar. The decision to go with a live-action format in a branching film eliminated the ability to create customized avatars. According to Subject 1, this approach might have been possible if the game had been animated. However, animation would have sacrificed the realism of the game, Subject 1 noted, adding "your usual virtual game where you have an animated person ... you just don't connect with that."

Another design trade-off in the games was increased complexity as defined by Annetta (2010). Rather than creating highly competitive games, with multiple levels, time trials, high scores, and badges or trophies for strong performance, the reward, according to all of the design team members interviewed was story, realism, and complex human narratives. As open learning games, according to Subject 3, *Post-Op* and *Home Visit* would have needed significant analytic and database support, and a dedicated server to track scores and in-game metrics. Of this decision, Subject 3 said, "when we first designed the game we realized points, values ...trophies, were not important." Subject 4 noted, like Subject 3, that design features like badges, leaderboards, competitive elements like time-trials or player competition "didn't fit" with the soft skills focus of *Home Visit*. She said that student testers noted they didn't feel pressure to "rush" through the game or to get a perfect score. According to Subject

4, the rewards of the game were gained from the storytelling and the process of working through the narrative and learning about the clients. Subject 4 shared that even overt points tracking, which was present in *Post-Op*, for *Home Visit* seemed out of place, saying: "how would you score something like this? ...that wasn't the focus." The games offer a linear but detailed narrative with a focus on a single patient family in each case. In this, the perspectives and game design diverged sharply from the Annetta (2010) framework. The design team's focus on limiting competition, rewards, levelling was attributed to a focus on an audience, nurses, who were said by the nursing educators on the team to be motivated by story and narratives.

Only somewhat emphasized in the interviews was the Annetta (2010) definition of informed instruction. According to the educators, the student usage of the games is regularly monitored and analyzed by the instructors who use these serious games. This means that the instructors consistently recalibrate how, particularly, *Home Visit* is used in the Toronto-based first-year class in which it is actively used. Students are encouraged to submit their reports from *Home Visit* to the instructor for review and to support discussion. The "assignment" of the games are informed by monitoring and analyses of student usage. For example, the grading weight the *Home Visit* is given in the course has been adjusted. Subject 1 notes: "...and all of my students do it and they get .05 of their mark for doing it, and another year they didn't lose even one per cent for not doing it." Subject 1 discussed an interest in implementing a research study to test the importance of in-classroom debriefing as a way to solidify student understanding of the material post-game. Subject 1's discussion recalls Lean at al. (2014) and Petranek et al. (1992) perspectives on the importance of debriefing in the learning cycle.

Another finding was the observation that when the participants spoke about interactivity and immersion there was a blurred distinction between these elements. Despite

the attempt in this paper to make a cleanly divided set of characteristics against each of the 6 I's with the constructed Annetta (2010) coding framework, immersion and interactivity were used interchangeably by the participants. Annetta (2010) links visual and audio stimuli with the concept of interactivity, while these qualities were bound up more closely with the idea of immersion in the discussions with the designers. The interview participants described the quality of the film footage as being in service of "immersion", giving players the feeling of being there in the midst of the action which pertains to identity as defined by Annetta (2010). For example, Subject 3 said of the filming and visual quality of the games : "There is this feeling you have when you watch these games. It helps to immerse into a game, seriously immerse you into the atmosphere and put you in the state of being a nurse." Subject 4 noted: "Everyone commented on how real it was, they felt like they were in movie, there was suspense. There were a lot of emotions, that came out, it brought out emotions, it got them involved. It was immersive." This blurring of the lines between these elements was a compelling finding, with the participants diverging from the Annetta (2010) framework in their understanding of immersion versus interactivity.

Discussion

ELT as defined by Kolb (1984) can help us understand some of the design decisions made during the production of these games and the final design of these serious games. As noted in the research context, ELT's learning cycle requires concrete experience (CE), reflective observation (RO), abstract conceptualization (AC) and active experimentation (AE). The cycle gives the learner 'hands-on' or direct experience (CE), a chance to observe and reflect (RO), time to develop ideas (AC), and an opportunity to test ideas in practice (AE). Overall, the design teams' expressed desire to create a realistic experience for the learning audience of nursing students was observed as a emphasized design imperative. The

decision to focus heavily on storytelling and narrative, lingering on the patient back story and character development particularly in *Home Visit*, the dramatic interactions and showing a wide range of emotional responses recalls Annetta's (2010) definitions of interactivity. Storytelling, for these game designers, meant complex characters and powerful, emotional narratives to mimic the complexity of real-life encounters and on-the-job experiences. This focus on interactivity and immersion observed in the design inventory and during the coding of the participant interviews can be understood as a desire to provide students with something "real", a concrete "experience" in a virtual world. The design decision making and game elements in support of interactivity specific to the complexities of social interactions can be understood as a simulated concrete experience (CE) in the ELT learning process. There was a drive to create a pervasive, always-on series of games that encouraged replayability, while trade-offs were made that decreased levels of identity and increased complexity as described by Annetta (2010). The designers' accounts of students deliberately attempting to get the wrong answers to see what happens or trying for a perfect score during multiple replays supports the idea of practice or experimentation in the learning cycle. Thus, these design decisions can be understood as a way to support student ability to engage in active experimentation (AE).

Both of the games are supported by full courses, readings and in-course instruction and in the case of *Home Visit*, online modules. They are, according to the interview participants, part of a wider instructional ecosystem. Rather than a 'sage on the stage' classroom lecturer, serious games give the learner a self-directed, *virtual* hands-on experience of the subject matter as part of a larger learning process. As such, these serious games are consistent with Annetta's (2010) directive of ensuring that they not be "a one-time adventure for the students…" but rather connected to other, contextualized learning materials. *Home Visit* connects the learner to additional readings if an answer is found to be incorrect. In this,

there is evidence of some diegetic or in-game scaffolding described by Annetta (2010) and Reigeluth et al. (2017). Further, there was the interesting discovery of how other learners outside of the nursing community are using the games. According to the interview participants, these games are being made a part of integrated instructional environments across Canada. At no point, based on the interviews, were the designers planning to create serious games that were meant to be standalone educational materials. Both *Post-Op* and *Home Visit* were planned as part of wider educational efforts, integrated into first-year courses. As such, they are embedded parts of courses supported by class lectures, online readings and other student supports which is supported by the findings in the interviews and game inventory, according to the participants interviewed. Students trying and failing in a low-penalty, low-stakes environment online, even sharing the experiences with friends and families, as well as the posting of summary reports in discussion forums in the case of *Home Visit*, provide students with an opportunity to engage in reflective observation (RO). Finally, students working with the other learning materials in support of nursing practice standards, for example, have an opportunity before, during and after the game to engage in abstract conceptualization (AC). This affords students with an opportunity to not only know that an answer is right or wrong but what theoretical, regulatory of best practice support the correct responses. In this, we can see the ELT learning cycle supported and at work in aspects of the game design of *Post-Op* and *Home Visit*.

Further Research

It must be noted that there were observed limitations in the research collection and methodology. Only four people in a large design team were interviewed. Although a mix of technical and nursing team members responded and participated in the interviews, without discussing the games with the entire, extended team, it is difficult to map the entire picture of

the design process. It should also be noted that the principal investigator had played the games several times before coding the interviews, therefore began the process with ideas about the games in mind. That said, every attempt to avoid bias and preconception was made during the coding process. There were challenges with the interpretation of in-game elements using the coding framework based on Annetta (2010). Some in-game elements, on their face, could have reasonably been interpreted as supporting multiple 'I' categories. For example, Irina's in-game dialogue could be interpreted as a means to support clear goals, a characteristic of immersion, by providing salient plot points to give the player necessary clues to make decisions. However, most of Irina's dialogue was found to land, in the coding process, more strongly under the category of interactivity and social interaction as they were observed to be in service of sharing emotional information, character details and a sense of the NPC's motivation. This reflection prompts a question about serious game NPC dialogue: how are these scripts written? Are they designed to enhance social interaction or guide the player through the learning objectives? How do script writers and game designers make these decisions? This is an area for further research.

Having run the Annetta (2010) framework through its paces, as it were, in analyzing these serious games, some questions emerge. Are there exceptions to be made with this framework based on the audiences that serious games address? The perspectives shared by the design team that they were tailoring their games with a specific audience in mind which resulted in a focus on some design elements. How does audience research shape game design? There is merit in exploring how this process is enacted in serious game design environments. Further, there was an expressed focus by the participants of providing students with a sense of identity in the game, by filming in a first-person POV, showing the player avatar interacting 'hands-on' within the virtual world. Annetta (2010) argued the ability to create a personalized avatar increased student engagement. If a different decision had been

made, for example, creating a 3D isometric, top-down view of the environment with a customizable third-person avatar interacting with patients, would there have been a greater sense of identity as defined by Annetta (2010)? This is an area for possible further research.

Conclusion

Using experiential learning theory (ELT) as defined by Kolb (1984) and the Annetta (2010) *I's Have It* framework, this Master's Research Project (MRP) has looked at how two serious games, *Post-Op Pediatric Clinical Simulation* and *Therapeutic Communication and Mental Health Assessment, Skills Practice: A Home Visit* were designed. These serious games were created to provide virtual patient encounters on the sensitive topics of pediatric surgery and mental health for a learning audience of first-year nursing students. The design collaboration and decision-making of the healthcare educators, and technical teams from Toronto-based post secondary institutions formed these unique serious games. These games were found to have many of the elements found within the Annetta (2010) conceptual framework for the design of serious games. Based on the interview participants' stated objective of creating authentic, simple, interactive, play-anywhere gaming experiences, the designers set about building learning tools for students who may not encounter these situations in their work placements or professional studies. The design teams' predominant focus on interactivity and immersion through storytelling, clear, easy-to-use controls, and visual and auditory stimuli can be understood as supporting an ELT learning process. The gaming experience offered by these serious nursing games provide educators and students with opportunities for concrete experience, reflective observation, abstract conceptualization and active experimentation in the ELT learning cycle. The serious games continue to be actively used to support nursing pedagogy.

51

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T. Pobuda

Appendix A
Project Team Standardized Interview Guide

1. Why did you decide to make a serious game vs. a more traditional learning module?
2. How did this particular project get started?
3. Who was the primary driver of this project?
4. What instructional theories and approaches were in play in the early project work?
5. How long did the project take?
6. What technology - hardware, software applications - were used to create the project?
7. What were some of the project barriers?
8. How was the project received by learners, instructors?
9. Did the final product meet your original expectations?
10. What were some of the lesson learned from this project? (Prompt: Any advice you'd give to other project teams?)
11. Do you think games work as learning tools?
12. What were some of the unexpected results of this project?

Glossary of Terms

Serious games: games that are created for learning, training or marketing rather than strictly entertainment.

Ludic: of or part of play

Educational learning theory (ELT): a theory created by David Kolb that suggests a knowledge creation is a "transformation process" with hands-on learning and concrete experiences as imperative parts of the knowledge acquisition and learning process

Standardized patients: actors displaying some possible symptoms or reactions to the health issues used during healthcare simulations

Pedagogy: the practice of teaching

Serious educational games (SEGs): an alternative name for serious games

Flow: a psychological state where a sense of time and sense disappears in the completion absorption or immersion in a task as defined by psychologist Mihály Csíkszentmihályi (1990)

Scaffolding: the use of instructional tools and techniques to assist a student with progressing through greater levels of learning acquisition and understanding, toward more independence and mastery

Informational ambiguity: a purposeful uncertainty within games to help players to enjoy the satisfaction of unlocking the mystery or solving the puzzle

Diegetic or nondiegetic scaffolding: in context of games, the game can help the player progress with diegetic or in-game scaffolding. In non-diegetic approaches, an instructor can provide the player outside the game with additional resources and coaching if the player is struggling

Debriefing: the process of discussing the game after game play, recounting experiences and contemplating new approaches, as well as discussing how the game play might apply in the real world

HTML5: The fifth and latest version of Hypertext Markup Language (HTML) used to present content online

Flowplayer: a commercial online video player

Computer Assisted Textual Markup and Analysis (CATMA.de): an open source text analysis tool created by teams at the University of Hamburg

Medium close up: a camera framing approach that when filming an individual frames the person's face and the tops of her, his or their shoulders

First-person point of view (POV): in this context, the action is viewed through the "eyes" of the player character

Non-playable character: a character encountered in a game that can't be used as a player avatar or character but is rather there for the purposes of giving the player characters with whom to speak and otherwise interact with