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by

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August, 2018

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Why Story Matters:
A Review of Narrative in Serious Games

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**Why Story Matters:
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by

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Report

Presented to the Faculty of the Graduate School
of the University of Texas at Austin
in Partial Fulfillment
of the Requirements
for the Degree of

Master of Arts

The University of Texas at Austin

August 2018

Dedication

To my family, who taught me the power of stories and the joy of learning.

Acknowledgments

I would like to express my gratitude to Dr. Liu and Dr. Horton for taking the time to read this report and to offer your invaluable feedback. Thank you, Dr. Liu, for your wisdom and for being an admirable mentor through my time in the Learning Technologies program. Dr. Horton, thank you for your expert advice on every program under the sun, from Unity to Sketch to Adobe Premiere. Many thanks to the *Alien Rescue* team, whose positive energy and creativity under the guidance of Dr. Liu made it such a pleasure to participate in the development of this program. I am also very grateful to Dr. Harrison who communicated to our Educational Research & Design class the immense usefulness of an annotated bibliography.

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by

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The University of Texas at Austin, 2018

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Abstract

In educational research, it is a widely accepted belief that meaningfulness benefits learning. According to many scholars, narrative is one method of making learning more meaningful to students. Research has suggested that serious games and other game-based learning environments can be improved by incorporating storytelling elements. This report investigates the role narrative can play in the experience of a learner engaging in serious games, and synthesizes research on features of story that have demonstrated success in these learning environments. Endogenous fantasies (as well as those intrinsically integrated into games), empathetic characters and virtual agents, and adaptiveness or responsivity are three characteristics of game narratives found to be effective in the literature across relevant fields. A proposal is made for enhancements to the existing narrative of the problem-based learning program *Alien Rescue* to foster greater immersion, engagement, motivation, and learning in this serious game. Game Discourse Analysis and the Narrative Centred Informant Design framework are also recommended for serious game designers and developers looking to make narrative a more prominent component of learning environments. The author advocates for design-based research as a methodology for creating serious game narratives with the greatest appeal to target learners.

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Chapter 1: Introduction

Every civilization throughout history has at some point relied on storytelling to understand and express their human experience (Krawczyk & Novak, 2006). Some educational theorists believe that narrative is the primary method by which we organize our interpretations of reality (Bruner, 1991). In the words of Dickey (2011), "Narrative structure is a pervasive part of human cognition; it is the means by which humans frame and recount daily experiences" (p. 456). From an early age, we make sense of the world around us by way of stories. For this reason, it is only natural that learning and narrative go hand in hand. Stories are easy to follow, and they are comprehensible because they introduce events in a familiar manner (Negrete & Lartigue, 2004). Curriculum can even be viewed as a kind of narrative itself, with teachers as the storytellers communicating pedagogical content knowledge to students (Gudmundsdottir, 1991).

According to Gros (2007), educators must modify their teaching methods to address the digital literacies needed in today's society. Serious games, digital games used to achieve ends beyond entertainment alone (Susi, Johannesson, & Backlund, 2007), offer an alternative medium for teaching and learning that may also help students build these competencies. Games can immerse learners in complex situations involving ill-defined problems with multiple solutions (Westera, Nadolski, Hummel, & Wopereis, 2008). A report on games in education found evidence that they can help students develop skills as varied as personal and social abilities, language and literacy, mathematical skills, creativity, knowledge and understanding of the world, and physical development (McFarlane, Sparrowhawk, & Heald, 2002). Serious games have the potential to be a strong learning tool; however, they must be well-designed and take

into account both pedagogic goals and an understanding of game design (Kenny & Gunter, 2007). In contrast to entertainment games, serious games include the goal of delivering learning content to the player, and this essential purpose should be considered at every stage of design and development (Mildner & Mueller, 2016).

Significance of Narrative for Learning Experiences

Central to the discussion of narrative within the educational sphere is the *meaning* with which it is thought to endow learning. "Meaning" is a term that is used liberally across educational literature. While cognitivism encourages meaningful information structures within memory and constructivism prioritizes individual meaning-making, both learning theories deem meaningfulness a necessary prerequisite for lasting learning to occur (Ertmer & Newby, 1993). Whether conceptual frameworks or personal histories, stories themselves are webs of information connected in meaningful patterns. As one article by Rowe and his colleagues states, "Much of the appeal of narrative-centered learning lies in the belief that narrative context provides a meaningful structure integrating pedagogical objectives into a unifying, coherent form" (Rowe, McQuiggan, Mott, & Lester, 2007, p. 40). It is this unity and coherence that narrative promises to impart to educational content.

Drawing from cognitive science and constructivist learning theory, Hirsh-Pasek and colleagues (2015) identified four fundamental pillars of learning environments: active, engaged, *meaningful*, and socially interactive. Though the purpose of their study was to inform the design of educational apps and to evaluate their merit, it could be argued these four pillars can be extended to the creation of other evidence-based educational products as well. Here, "meaningful" referred to learning that is purposeful and that holds personal relevance to the learner. The authors advocated for embedding

information within familiar contexts and narratives to achieve this end. According to their model, pedagogical concepts and challenges should be smoothly integrated into plotlines to encourage retention.

According to Negrete and Lartigue (2004), narratives such as novels, comics, plays, and other stories hold the potential for making science more meaningful to students. Bridging the gap between science education research and the realm of popular culture, the authors encouraged educators to embrace mass media and entertainment technologies in teaching and learning science. One method they proposed was to use fictional narratives to offer students the opportunity for freedom of interpretation and negotiation of meaning rather than explicitly laying out the facts before them. From a cognitive science perspective, narratives maintain the attention of the reader because they are less authoritative, and they leave room for ambiguity and imagination (Negrete & Lartigue, 2004). Illustrating their view on narratives for making sense of scientific concepts, Negrete and Lartigue explained, "Literary tools are the best way to describe a world in which reality exists only at the level of human experience" (2004, p. 121). Other scholars have posited that science education can be made more meaningful through narratives that humanize it and contextualize it through connections to technology and society at large (Barab, Sadler, Heiselt, Hickey, & Zuiker, 2007). Narrative's facilitation of meaning-making could also make it a valuable tool within the framework of discovery learning (Rowe et al., 2007).

Goals of the Report

This report seeks to connect the two areas of narrative and game-based learning. The goal of this exploration is to develop an understanding of the role story elements can play in the learner experience in a serious game. In some of these learning

environments, narrative is peripheral. In others, it is a key focus; "narrative-centered learning environments" are a category of serious games that implement strong interactive story scenarios toward an educational goal (Rowe et al., 2011). Digital game narratives, including those in serious games, are diverse and numerous, ranging from realistic everyday contexts to those that take place in fantasy worlds and spaces. Importantly, game stories are set apart from narratives in other media in that they are more interactive, less fixed, and frequently controlled by the player (Qin, Rau, & Salvendy, 2009). In the commercial games industry, teams of professionals such as game writers and narrative designers are tasked with applying dramatic writing principles to interactive virtual experiences (Krawczyk & Novak, 2006). However, there is currently a lack of sufficient academic research connecting narrative and learning in the context of serious games. This review integrates the research that is available from a wide variety of fields at once disparate and united through a common focus on the experience of a learner or technology user. These include educational technology, psychology and the learning sciences, instructional design, human-computer interaction, information and communication technology, cyberpsychology, and artificial intelligence.

Research questions.

Within this investigation into serious game narratives, the author specifically sought the answers to the following three research questions:

RQ1: In what ways can narrative impact the experience of a learner in a serious game?

RQ2: What narrative features have been associated with immersion, engagement, motivation, and/or positive learning outcomes in a serious game or other digital game?

RQ3: How can these findings be applied to strengthen the narrative of *Alien Rescue*, a problem-based learning environment for 6th grade science students?

These three questions are increasingly detailed in the hopes of attaining both a broader understanding of narrative in serious games as well as a more focused look at how storytelling elements can be applied in a real-life game for learning.

Following this introductory chapter, Chapter 2 of the report will present a literature review surveying the existing research on narrative in serious games. First, to answer **RQ1**, four potential narrative "roles" in these spaces for learning that emerge from the literature will be considered. Secondly, the review will turn to research on specific features and qualities of effective game narratives to address **RQ2**.

The third chapter of this report will speak to **RQ3**. A mini-case analysis of the instructional program *Alien Rescue*, developed in the lab of Dr. Min Liu at The University of Texas at Austin, is offered. Suggestions for enhancements to the game's existing narrative based on the findings of the literature review are outlined. The report concludes in Chapter 4 with a discussion of the implications of the investigation and recommendations for future research in the area of serious game narratives. It is the hope of the author that this report will shed light on narrative design of serious games to enhance the immersion, engagement, motivation, and learning gains of students who play them.

Chapter 2: Literature Review

The literature review that follows relays results from empirical educational and technological research, including quantitative, qualitative, mixed-methods, and design-based studies. The first section will discuss relevant findings on the ways in which narrative can help shape the learner experience in serious games. Section two will take a closer look at some of the narrative features and storytelling elements that have demonstrated success with users in serious games and other digital games.

Selection of Articles for Literature Review

Empirical studies surveyed in the literature review that follows were selected from an assortment of peer-reviewed journals, books, and conferences. In an effort to sample research across a wide variety of associated disciplines, the literature search was not limited to any specific journals. Some of the journals most commonly sampled in this review were the *Journal of Computer Assisted Learning*, *Educational Technology Research and Development*, the *International Journal of Human-Computer Studies* and the *Journal of personality and social psychology*. The journals consulted were chosen primarily based on their pertinence to educational technology or other closely related fields.

In sum, this chapter's literature review referred to 36 articles. The years in which these empirical studies were published ranged from 1992 to 2015, though the majority of these had publication dates between 2005 and 2015. Additionally, classic education and psychology studies from the years 1978 to 1997 were used to frame the discussion. Google Scholar, along with the databases Springer, The ACM Digital Library, ResearchGate, ScienceDirect, APA PsycNET, and The University of Texas at Austin Online Library were used to conduct a search for these particular articles. The author identified relevant keywords, including "narrative," "story," "serious games," and

"interactive learning environments," and combined them in searches. Other search terms, such as "narrative-centered learning environments," emerged from the literature and led to the location of additional articles. Finally, some papers were chosen from the references sections of articles that the author found through database searches.

The Role of Narrative in Serious Games

How can the existence of a narrative, plot, or story make a difference in the experience of playing a serious game? Hassenzuhl (2010) described how technologically-mediated experiences should be designed to be positive, providing fulfillment through technology and a sense of being valuable and worthwhile. The research examined here explores the experiential impact of serious game narratives across four dimensions: immersion, engagement, motivation, and learning gains.

Narrative and immersion.

One element of games that has appealed to players across time is the idea of getting lost in the game world. This experience of time loss and disconnecting from the real world is referred to as "immersion," but a clear understanding of this variable does not yet exist in the research (Jennett et al., 2008). Flow, cognitive absorption, and presence are three components thought to make up immersion (Jennett et al., 2008; Qin et al., 2009). Csikszentmihalyi's (1997) ubiquitous concept of flow has been used over decades to describe a state of total absorption or engagement in an activity, educational or otherwise. Presence is commonly understood as a sense of "being there" (McQuiggan, Rowe, & Lester, 2008b, p. 1512) in an environment, resembling the feeling of being in a tangible place, and is often used synonymously with immersion (McMahan, 2003). Presence also relates to flow; while they are not the same construct, there is some overlap such as time loss and intense focus (McQuiggan et al., 2008b).

Finally, cognitive absorption (Agarwal & Karahanna, 2000) is a deep state of involvement with software (Qin et al., 2009). Using university students as participants, Jennett et al. (2011) conducted three experiments investigating the concept of immersion in games, establishing that the variable can be measured both *subjectively* (through questionnaires) and *objectively* (through task completion time or eye-tracking).

Unlike in traditional narratives such as novels or movies, the audience interacts with the story itself in a game. Because the structure of game narratives varies wholly from that of other types of media, existing measures of narrative are not sufficient to understand the experience of a game player (Qin et al., 2009). To address this need, Qin et al. (2009) used exploratory factor analysis and confirmatory factor analysis to develop and evaluate a measure of seven dimensions of immersion in a game narrative.

University students were asked about their computer game experiences on a questionnaire employing 7-point Likert-scales ranging from strongly agree (7) to strongly disagree (1). Cronbach's alpha was used to establish internal consistency; construct validity and content validity were confirmed using statistical validity analysis. The dimensions they ultimately decided upon were curiosity, concentration, challenge and skills, control, comprehension, empathy, and familiarity. The findings of this study could provide guidelines to measure narrative immersion in a serious game.

How can a narrative help to immerse a player in the game environment? According to a cyberpsychology study by Wood, Griffiths, and Park (2007), time loss is common in video games, with 99% of respondents ($N = 280$) stating they had lost track of time while playing a game. These self-described gamers reported their gaming behaviors in an online survey. Open-ended responses were analyzed using microanalytic content analysis. Coding followed, with researchers identifying thematic

response categories, then fine-tuning them. In players' descriptions of their experiences, plot-driven stories were one characteristic frequently linked with time loss in games. Wanting to know what happens next in a story was a common theme that emerged from the data. For example, one participant felt most absorbed playing games with "strategic components that contribute to a narrative", explaining further: "I get caught up because I want to solve the current problem in order to find out more of the storyline and explore a new environment" (p. 41). While self-report data on a survey can never be as conclusive as experimental data, these results at least suggested that video game players believed story elements have made an impact on their experience of immersion in the games they play.

While some researchers have framed immersion in a game as time loss, others have looked at its subcomponents such as the aforementioned construct of presence. McQuiggan et al. (2008b) performed two quantitative studies investigating the effect of empathetic virtual characters on presence in narrative-centered learning environments, specifically in *Crystal Island*. *Crystal Island* is an inquiry-based learning environment centering around a science mystery related to microbiology and genetics. In both middle and high school populations, empathetic characters had a significant effect on learners' reports of presence in the game. These findings will be described in more detail in the following section on features of effective game narratives. It seems that narrative can impact immersion by inviting players to participate in the story using characters and backgrounds, thereby drawing them into the experience of a game (Sweetser & Johnson, 2004).

Notably, a quantitative study of *Crystal Island* also demonstrated a significant effect of narrative on student presence in the game environment (McQuiggan, Rowe,

Lee, & Lester, 2008a). In this experiment, the entire eighth grade population of a middle school in North Carolina was randomly assigned to one of four groups: holdout, *Crystal Island* narrative condition, *Crystal Island* minimal-narrative condition, or PowerPoint condition. With the exception of the holdout (control) group, which received no intervention, the same microbiology curriculum was delivered across all conditions. The narrative condition group played the complete *Crystal Island* game containing a positioning scenario and characters with rich personalities and backstories, while the minimal-narrative condition group played the same game stripped down to only the most basic narrative to support the curriculum. Students in the PowerPoint condition were taught using a slideshow presentation of the same microbiology curriculum with no story. Students' reported presence (on the Presence questionnaire) in the story world of *Crystal Island* was significantly higher in the narrative condition than in the minimal-narrative condition. These results implied that integrating more sophisticated narrative elements into a serious game can positively impact the immersiveness of the player experience.

In addition to effects of narratives on immersion, the immersive qualities of narrative have also been found to influence beliefs and attitudes about subject matter. In communication theory, "transportation" or immersion into narrative worlds (Green, Brock, & Kaufman, 2004, p. 311) refers to a media consumer's experience of cognitive, emotional, and visual absorption in a narrative and its characters. A series of experimental social psychology studies by Green and Brock (2000) revealed an association between the level of transportation (as measured on the transportation scale they developed and evaluated) and both favorable attitudes toward protagonists and

the overall persuasiveness of the narrative. Examining these findings, it appears that narratives may play some role in how immersed players feel in a virtual environment.

Narrative and engagement.

Engagement can be behavioral, emotional, or cognitive; it refers to the ability to maintain attention on a task (Hirsh-Pasek et al., 2015). The subject of how gamification and serious games can augment engagement in the learning experience has been of significant interest to researchers in the field of educational technology. Game-based learning has been associated with increased engagement across a variety of contexts (Annetta, Minogue, Holmes, & Cheng, 2009; Huizenga, Admiraal, Akkerman, & Dam, 2009). However, the majority of these studies compared learning in serious games to regular project-based instruction and did not specifically look at the role narrative may played in contributing to this student engagement.

How can narrative get students interested in learning in serious games? As Barab et al. state, "The content of narrative is self-evidently appealing: we lose interest in a world without story" (p. 61). The findings of Hallinen, Walker, Wylie, Ogan, and Jones (2009), although not completely illuminating narrative's role independent of other game elements, did shed some light on this area. Their quantitative study looked at the addition of game and narrative elements to an intelligent tutoring system designed for teaching French language. The researchers developed two computer-based environments for language-learning with past and imperfect tenses of French as the content. In the narrative game environment, students played the part of a journalist editing newspaper articles and choosing the correct forms of verbs. They also inserted game elements such as time pressure, levels, and points. The control group played the non-game version, and the treatment group played the game version. Students

expressed significantly more engagement (ratings on "engaging," "enjoyable," and "easy to use") in the game condition. A key limitation of this study was that narrative and game elements were not separated for comparison, but considered together in one version of the intelligent tutoring system compared with traditional computerized instruction. While it is difficult to extricate narrative from gamification here in drawing conclusions, it seems that narrative provided a meaningful structure in the concept of the journalist's office, without which gamification could not have been easily applied.

Relationships among the various subcomponents of engagement and related concepts are unclear; for example, in some research, flow is thought to be an aspect of engagement, rather than immersion (Rowe, Shores, Mott, & Lester, 2011). Curiosity is another term often used to refer to engagement. A qualitative case study by Dickey (2011) looked at narrative design and its impact on students' experience in a game-based learning environment called *Murder on Grimm Isle*. Dickey examined in particular how adventure-styled narrative fostered argumentation writing through curiosity, among other mediators. This serious game was designed to help students cultivate persuasive writing skills in secondary school. Data collection methods included observations of student interaction (chat logs within the game and in-person communication in the lab), questionnaires about the use of the game, and informal interviews. Within this narrative, students investigated a crime by gathering evidence and determining the culprit. The results of this study indicated that the storyline of *Murder on Grimm Isle* enhanced participants' curiosity and sustained it throughout the narrative. Dickey observed that curiosity appeared to play a notable role in the dynamics of the game. She believed that for many learners, plausibility arose from an interplay between the narrative storyline and affordances of the game environment.

Curiosity and engagement in a serious game were also elicited in students by way of the narrative technique of Game Discourse Analysis (GDA) in a study at a university in The Netherlands (Wouters, Van Oostendorp, Boonekamp, & Van der Spek, 2011). GDA functions by implementing foreshadowing and backstory, manipulating the flow of information in such a way that promotes curiosity about what will happen next in a story. Here, GDA was employed in the serious game *ReMission*, in which players travel through the bodies of cancer patients to fight disease and infection. To apply this method to the game, an information flow was produced, then some of the component elements were foreshadowed by showing the relevant scenes to the player before the action began. While the use of GDA did not have an effect on learning, this strategy of incorporating narrative was associated with greater self-reported curiosity. An experiment by Park, Lee, Jin, and Kang (2010) showed similar findings: players who had been exposed to a pre-game story about the main character rated their enjoyment of the game significantly higher than those who had not. Interestingly, evaluation of the game was mediated by presence, suggesting another relationship between immersion and engagement.

Narrative and motivation.

Another role of serious game narratives seen in the literature is their relationship to motivation toward learning. Motivation--and particularly, intrinsic and extrinsic motivation--is a frequently discussed topic in educational research. While extrinsic motivation is associated with an external reward that drives behavior, intrinsic motivation arises out of inherent interest in a task for its own sake. Motivation is essential in a technology-based learning environment, as software that does not capture the attention of the learner will not be used (Rowe et al., 2007).

Just as immersion and engagement are often discussed jointly, engagement and motivation appear to be closely related as well. According to Habgood and Ainsworth (2011), "[t]he concept of intrinsic motivation has been considered to lie at the heart of the user engagement created by digital games" (p. 1). Curiosity, discussed previously as synonymous with engagement, is also one of four intrinsic motivators toward learning with computer games in a taxonomy by Malone and Lepper (1987): challenge, curiosity, control, and fantasy. Many modern-day studies are rooted in this classical piece of literature. A qualitative study of *Crystal Island* used the work of Malone and Lepper (1987) as a launching pad for their research on student motivation within this narrative-centered learning environment (Rowe et al., 2007). Researchers were interested in determining how narrative in *Crystal Island* might impact motivation of middle school students. In this inquiry-based learning environment, the player explores a research outpost on a volcanic island and solves a science-themed mystery as members of the research team begin to fall ill. Inquiry-based science learning tasks (e.g., question development, hypothesis generation, and data collection) are embedded within the narrative. The narrative is also responsive to user input, offering a number of possibilities for the story and educational content of the game. Ultimately, the player wins the game by gathering information and deducing the cause of the disease, a genetic trait of chickens causing them to lay infected eggs. *Crystal Island* employs Malone and Lepper's (1987) four factors in the hopes of increasing student motivation (outlined in the table below).

Table 1

Malone and Lepper's (1987) taxonomy of intrinsic motivators as applied to Crystal Island, summarized from a paper by Rowe et al. (2007)

Intrinsic motivator	Key points from Malone and Lepper's (1987) taxonomy	Application in <i>Crystal Island</i> game narrative (Rowe et al., 2007)
<i>Challenge</i>	Tasks that have the optimal level of challenge (not too easy or too difficult) will be maximally motivating for students.	Challenge is achieved in <i>CI</i> with pedagogical and narrative goals (tasks that reveal information or advance the plot). Fixed goals are built into the narrative while emergent goals stem from the player's choices in the interactive narrative.
<i>Curiosity</i>	Discrepancy between the students' current knowledge and skills and the expected knowledge and skills as an outcome of the activity maintains the interest of students.	A mystery narrative offers an incomplete understanding of events, baiting the learner into fleshing out their knowledge and spurring them towards solving the mystery.
<i>Control</i>	Students are more motivated when they experience a sense of power and choice over learning.	Interactive narrative environments largely hinge on control. Students' decisions influence the development of the story, encouraging their sense of their own competence and motivating them. Almost all events in <i>CI</i> are dependent upon learners' actions, which offers them choice and freedom in the story.

Table 1 (continued)

<i>Fantasy</i>	It is motivating for students to imagine and build mental models of situations outside of reality. Fantasies can also provide access to the other three motivators, even if they are not present in real life.	Fantasy frequently offers metaphors for understanding the pedagogical material. In <i>CI</i> , learning through the scientific method and exploration are key objectives for the game, and they are closely intertwined with the mystery itself. Affective experiences play a large role in making fantasy motivating. Fantasy can inspire emotional responses in students and offer chances to empathize with non-player characters.
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Focus groups and individual interviews revealed that the 8th grade students found the narrative elements inspired by Malone and Lepper (1987) that were incorporated into *Crystal Island* motivating (Rowe et al., 2007). Students suggested more conflict and red herrings in order to promote *curiosity*. They preferred interactive scenarios to non-playable cutscenes, indicating their desire for *control*. Learners hoped for characters with whom they could develop relationships and engage in richer conversations, speaking to the *curiosity* and *fantasy* motivators. Some students wished they could design their own characters, offering them *control* and greater investment in the story. They posed suggestions for the setting, inventing new areas of the island to explore that would spark their *curiosity*. Finally, many students felt that short "mini-games"--for example, labeling parts of a cell when examining contaminated food under a microscope--would offer additional opportunities for learning through *challenge* and *curiosity*. One limitation of this qualitative study was that the researchers sought out evidence of the motivating influence of the four factors, rather than letting themes appear from the data. However, the commentary of students after playing *Crystal Island*

did suggest that narrative in this serious game tapped into their intrinsic motivation across these multiple dimensions.

Fantasy narratives in particular have been found to increase student motivation in some cases. A highly referenced psychology study investigated the effects of fantasy contexts for instructional materials on students' motivation and learning (Parker & Lepper, 1992). Researchers compared four different versions of an educational computer-based activity designed to teach children the basics of the Logo programming language. The control condition contained problems presented in a basic, abstract form with drawings and geometric shapes. The other three versions included the same information, but it was presented within a fantasy context: pirates searching for treasure, detectives catching criminals, or astronauts searching for new planets. Their first study (out of two) examined whether the "fantasy embellishments" would influence students' a) interest in, and b) choice of, that activity. The 3rd and 4th graders participating were shown samples of all four programs and instructed to rank their interest in them. In a second session two days later, the children were asked which game they would like to play. Confirming the hypothesis, the rankings were significantly ($p < .001$) higher for the fantasy versions than the no-fantasy version. In the second session, the children were also significantly more likely to choose to play the three fantasy versions of the activity (6.4% chose the no-fantasy, 36.2% chose pirate, 29.8% chose detective, and 27.6% chose space). One key takeaway point from this study was that the differences between fantasy and no-fantasy conditions were subtle, such as substitution of phrases (e.g., "touch each circle" vs. "land on each planet") or simple line drawings (e.g., "connect the circles" vs. "find the other pirates and bring them back to the ship"). These findings could be encouraging to game developers as they intimated

that narratives and plots need not be high-concept to engender intrinsic motivation in learners.

A narrative-based framework was also used to enhance student motivation in a multimedia-rich interactive learning environment (ILE) called BAT for teaching binary arithmetic and logic gates at the university level (Waraich & Brna, 2008). The goal of this design-based research was to design and develop an engaging learning experience that would heighten the motivation of some first-year undergraduate students who found the subject of computer architecture dry and difficult to approach. The method applied here, the Narrative Centred Informant Design (NCID) framework (Waraich, 2004) is a user-centered design model that considers students "informants" (p. 99) to the design process. In keeping with an instructional design paradigm, the researchers thoroughly considered user needs in deciding upon key aspects of the game environment--so much so that they directly involved the users in the design of major plot points and characters. Students played a central role at every step of the design process, from discussing the overarching structure of the narrative to storyboarding to scenario creation. A focus group of five students made principal design decisions such as a science fiction genre, a time travel synopsis, and puzzles being used to teach learning objectives. The researchers commented that if their focus group had not stressed the importance of humor to the narrative, they would not have been inclined to add this element. In an evaluation of BAT, all students who used this software reported that they enjoyed it and that the story was a primary reason for their engagement (59.0% of students rated the game as "good"; 27.2% rated it as "excellent"). Results also indicated that the students who showed the most enthusiasm for the narrative were also those struggling the most with the subject matter. This method described may offer

one way to increase the likelihood of a serious game narrative appealing to and motivating target learners.

Motivating results of narratives in serious games can be found among special needs populations as well (Quinn, 1996). In one case, low-literacy youth were trained on independent-living skills using a computer-based simulation called *Quest for Independence*. Narrative was found to provide guidance to learners, spurring them along as they navigated through a fictional city.

Narrative and learning gains.

It appears from the research cited above that narrative can make the learner experience in a serious game richer by way of immersion, engagement, and motivation. However, as Parker and Lepper (1992) speculate, "What difference, then, does it make if learning *is* more fun?" (p. 628). Firstly, it can be argued that a more enjoyable learning experience is valuable in its own right because it may increase time students want to spend learning. Additionally, there is evidence to suggest that the existence of narrative may be associated with greater learning outcomes in serious games. The research studies that will be presented next evaluated narrative's effect on learning gains, both quantitatively and qualitatively.

Quantitative studies.

In their experimental studies on fantasy contexts in learning the Logo programming language, Parker and Lepper (1992) did not only examine motivation, but they also wanted to determine whether this motivation might translate into learning. In a second experiment, thirty-two third-graders were randomly assigned to one of three conditions: individualized fantasy (choice of three fantasies), assigned fantasy, or no fantasy. There was no difference observed between individualized and assigned fantasy

conditions, so these results were combined and compared against the no-fantasy group. On the immediate test, students in the fantasy conditions exhibited significantly greater learning gains than in the no-fantasy condition ($p < .05$). On the retention test, once again, the students in the fantasy conditions outperformed the no-fantasy condition students ($p < .05$). In generalization of learning measures (general geometric concepts), there was no significant difference immediately, but one appeared in the delayed test. Here, a fantasy narrative alone made a marked impact on student learning in a serious game. It was particularly noteworthy that the same effect occurred regardless of whether the fantasy had a detective, pirate, or space theme. Waraich's (2004) evaluation of the ILE for teaching computer architecture in higher education showed favorable effects of narrative on learning as well. Pre- and post-test results indicated students who were exposed to BAT, the narrative-rich ILE, improved their scores, although a ceiling effect was seen in the data. The comparison groups who did not use the software, by contrast, showed no improvement, and a slight deterioration, for CS (Combined Honours) students and MS (Modular Degree Scheme) students, respectively. These two sets of findings suggested that serious games with prominent narratives could provide learning benefits across multiple age groups and experience levels.

Another quantitative study that inquired into the potential learning benefits of narrative was conducted by Rowe et al. (2011). Specifically, these researchers wanted to know if engagement in a narrative-centered learning environment would be associated with learning. A large group of middle school students ($N = 153$) played the *Crystal Island* game for teaching microbiology, which was in its third major iteration at time of this study. Narrative is central to this game, as player exploration, dialog, and virtual lab investigations are embedded within the overarching mystery story. In this learning

environment, narrative is distributed over multiple areas of the game, such as in posters in camp buildings or books located in a library. Overall, student engagement in *Crystal Island* was strongly linked to greater learning gains and problem-solving in the game. All three measures of engagement (presence, situational interest, and final game score) were significantly associated with post-test score when controlling for background knowledge in microbiology. Independent of prior knowledge or game-playing experience, "both gamers and non-gamers" (p. 128) who were engaged achieved positive learning outcomes. These results challenge the belief of many scholars that engagement and learning gains in a serious game are at odds.

Qualitative and mixed-methods studies.

Qualitative and mixed-methods studies of the serious games *Murder on Grimm Isle* and *Quest Atlantis* illuminated to some extent the process by which the immersion, engagement, and motivation generated by narrative in serious games may impact learning.

Dickey (2011) observed how engaging with a murder mystery in the adventure game *Murder on Grimm Isle* translated into argumentative writing skills in her students. The goal of the game is not to "win" but to create a cohesive argument using artifacts and text. These students, 20 undergraduates at a Midwestern university in the USA, played the game and then presented an argument on who they believed to be the culprit and evidence to support their allegations. Eighteen students chose a culprit and used at least three pieces of evidence to back up their argument. These accounts included a wide variety of motives for the crime, including rejection, accidents, stalking, and characters trying to frame one another. From student writings, it appeared that the learners were drawing from preexisting schemas of crime investigation and detective

narratives. According to Dickey, transfer of game-based experiences into prewriting may have been achieved through the engagement and motivation afforded by the mystery narrative.

A mixed-methods study by Barab et al. (2007) used both naturalistic inquiry and outcome measures to determine whether learning was attained by students playing the narrative-centric game *Quest Atlantis*. The developers introduced a "socio-scientific narrative" (p. 59) to engage students in this virtual world for inquiry-based learning in an aquatic habitat simulation. This study was rooted in the belief that students should take part in inquiry processes, developing an integrated understanding of complex socio-scientific problems. The authors theorized that a high quality MUVE (multi-user virtual environment) includes rich narrative that places users into the role of protagonist as they solve in-game problems and allow them to try on and grapple with new ideologies. Their focus was educating students on problems that do not have clear-cut answers, but require a balance of scientific knowledge with political, economic, and ethical considerations. Three core components were central to the design of *Quest Atlantis*: *narrative*, *inscription*, and *inquiry*. The *narrative* needed to be compelling to students and to contextualize scientific content, granting it greater meaning. *Inscriptions* were written forms of data such as diagrams, charts, and tables; they served as conceptual tools representing the data in a simplified way, extracted from the larger narrative. The third component was scientific inquiry, through which students used resources, exploration, and discovery to solve problems. The storyline in this *Quest Atlantis* unit centered around an environmental problem occurring in Taiga Park, a decline in the fish population with several key stakeholders: the fishing company, the logging company, and the indigenous people. Students were tasked with posing a

solution to the problem integrating scientific evidence with other societal considerations.

This study followed a 10-day intervention in a 4th grade gifted class of 28 students in a Midwestern town (Barab et al., 2007). Learning was considered on four levels: immediate-level, close-level, proximal-level, and distal-level. The qualitative data collected were multifarious and included direct observation and field notes, interviews with students and teachers, document analysis, and student writing "Quest" (p. 62) submissions where they argued for a solution to the problem. Quantitative data consisted of outcome measures, both traditional tests of relevant concepts and state-standard scientific assessments. First, there was considerable evidence that learners were engaged in the narrative. Students often referred to characters as if they were real, and even expressed frustration at their behavior. The narrative was dispersed across various locations in the game, and players were actively involved in searching out answers and uncovering information. The scientific inquiry was highly social, and students defended characters in the story and took on their points of view. In their Quest submissions, all student groups appeared to balance economic and ecological issues, and they acknowledged the complexity and nuance of the situation at hand. Students' responses demonstrated an understanding of the importance of multiple perspectives on the issue and an awareness that problems can exist within any solution. Outcome measures substantiated that student learning took place as well. On a typical classroom assessment, the class mean on the pre-test was 1.7, and the mean on the post-test was 4.0, a statistically significant change ($p < 0.001$). On state standard assessments, students scored an average of 13.5/18 on the pre-test, and the mean post-test score was .67 items higher. These qualitative and quantitative results provide evidence in support

of the idea that students enriched their understanding of these socio-scientific concepts, at least in part owing to the Taiga Park narrative in which learning was situated.

Considered holistically, the results of these quantitative, qualitative, and mixed-methods studies largely support the hypothesis that narrative elements in serious games can enhance learning. It is not entirely clear *how* narrative could function towards greater learning, and more research should be conducted in this area. However, it appears that immersion, engagement, and motivation may be mediating variables that bolster this effect. Narrative-enhanced learning experiences within serious games *Murder on Grimm Isle* and *Quest Atlantis* speak to this multilayered process.

Analyzing the Features of Effective Game Narratives

Up until this point, this review has surveyed research on the role narratives can play in serious games to promote learning. Next, it will turn to more specific qualities and features of game stories that have shown favorable outcomes. It is important to note that research in this area is limited and that not all studies deal with narratives in serious games specifically, but some more broadly target game narratives in general that have promoted a positive player experience.

Endogenous fantasy and intrinsic integration.

The topic of intrinsic and extrinsic motivation is central to educational research in general, and it is critical in the discussion of fantasy in serious games. Returning to Malone and Lepper's (1987) taxonomy, challenge, curiosity, control, and fantasy are thought to be four key intrinsic motivators in serious games. Malone (1981) argued that fantasy supports intrinsic motivation, especially when the fantasy is *intrinsic to gameplay* because it relates more to how a skill might be used in a real-world setting. Using

parallel concepts, Rieber (1996) explained how fantasy in a learning game could be either *exogenous* or *endogenous* to the content of a game. According to him, exogenous fantasy is frivolous because "any content can be superimposed on top of this fantasy" (p. 50). Endogenous fantasy, by contrast, is more suitable for educational purposes because it weaves pedagogical content together with the fantasy so that one cannot exist without the other. In these types of games, if a student is interested in and motivated by the fantasy, they will consequently be interested in and motivated by the learning content.

Habgood and Ainsworth (2011) approached the issue of endogenous or intrinsic fantasy narratives in serious games from a learning sciences perspective. In two quantitative studies, these researchers looked into the impact of *intrinsic integration* of fantasy on both students' learning outcomes and their choice of game (a measure of intrinsic motivation). As opposed to the common practice of using games as "a sugar-coating for learning content" (Habgood & Ainsworth, 2011, p.1) the authors posed intrinsic integration as an alternative method of employing fantasy, interlacing narrative, gameplay, and pedagogy within a serious game. Habgood and Ainsworth built off of the work of Malone and Lepper (1987) by adapting their idea of intrinsic and extrinsic fantasy to "integration," emphasizing the key relationship among game mechanics, fantasy, and pedagogy. In general, game developers can achieve intrinsic integration by creating a strong connection between a game's core mechanics and its learning content.

For these studies, Habgood and Ainsworth (2011) designed a game for teaching math to 7 to 11 year-olds called *Zombie Division*. In the intrinsic version of the game, players mathematically divided opponents in order to defeat them. In the extrinsic version, combat was not related to math, but instead, math multiple choice questions

were sprinkled in-between levels. The control version did not contain any math content. Study 1 looked into learning gains of 58 students who played intrinsic, extrinsic, or control versions of the game for two hours in their classroom. Study 2 gave 16 children free choice between intrinsic and extrinsic versions of the game and compared how much time they spent playing each. Under fixed time limits, the results suggested a significantly greater improvement in math learning in students who played the intrinsic version. Additionally, students in Study 2 spent seven times longer choosing to play it than the extrinsic version ($p < 0.001$). In a group interview after the study, students explained that they preferred the intrinsic version because they found the extrinsic version slower, less fun, and too easy. The results of this study provided evidence in support of both the motivational and educational benefits of intrinsically integrated narratives and gameplay in serious games. Importantly, the authors stated that game contexts need not have a fantasy or science fiction genre, but can also center around everyday situations, as long as they are connected intrinsically to the content of the game. One example of this type of intrinsic integration being used to promote learning is *Braingame Brian*, developed by researchers in the Netherlands for executive function training in children with ADHD and cognitive control problems (Prins et al., 2013). The narrative of this game is merged seamlessly with the gameplay and learning content, as the main character Brian helps the villagers in his fictional town solve problems by completing training tasks that are disguised as Brian inventing machines. A pilot study of forty children (clinically diagnosed with ADHD) showed that those using *Braingame Brian* significantly improved their symptoms. Continued research on this program is needed, but researchers hoped the game world could also enhance intrinsic motivation, a common deficit of children with ADHD.

Many of the serious games described in the research discussed above employ endogenous, intrinsic, or intrinsically integrated fantasies. Endogenous fantasy is a vital element of *Crystal Island* because the scientific mystery storyline is the skeleton of the whole game, without which learning objectives would have no context (Rowe et al., 2007). In incorporating narrative and game elements into their intelligent tutoring system, Hallinen et al. (2009) also aimed to integrate them organically rather than tack them onto the language-learning tasks. Learners assume the persona of a newspaper editor choosing the correct form of French verbs, and content is intrinsically integrated in this manner. The feedback system is especially closely intertwined with the narrative, as the player's boss gives corrections via e-mail. *Quest Atlantis* (Barab et al., 2007) also employs fantasy that is highly endogenous to the learning content. The "fish kill" plotline of Taiga Park is instrumentally related to scientific concepts in the lesson such as water quality and erosion. Here, the entire socio-scientific inquiry process hinges on the narrative of an environmental problem within a fictional civilization of Atlantis, a planet in need of students' help. Though the subject matter of each is distinct, one would be hard-pressed to extricate the fantasy narrative from the educational content of any of these games.

Empathetic characters and virtual agents.

While endogenous and intrinsically integrated narratives can bolster the motivation of learners, strong characters can help to pull the learner into the story by way of immersion. According to Hirsh-Pasek et al. (2015), effective learning environments can provide social interactivity through "parasocial relationships" (p.19) in which on-screen characters appear to be interacting with the viewer. Characters to whom learners relate hold the potential to influence their attitudes and decisions. For

example, experiments by Kotler, Schiffman, and Hanson (2012) revealed that children were more likely to indicate a preference toward a food that their favorite character liked, and that they were more willing to try a healthy food if the character was promoting it.

In creating characters for serious games, some researchers believe it is essential to consider the empathy of the relationship between the player and the non-player characters (Paiva et al., 2004). In 2007, Rowe et al. performed a study of the narrative-centered learning environment *Crystal Island* in which students expressed a desire for deeper characters with whom they could interact and develop relationships. The following year, McQuiggan et al. (2008b) analyzed the effect of empathetic exchanges with characters in *Crystal Island* on player experience. Characters serve various roles in this game, such as helping to identify clues or offering scientific insight to the player. Students completed a demographic inventory that also measured their empathetic nature. After playing the game, they reported perceptions of *Crystal Island* virtual humans and presence. Participants were randomly assigned to control or empathy conditions. The empathy condition included three empathetic characters: Jin, the camp nurse, Elise, the lab technician, and Audrey, a research assistant. All three characters asked students how they were feeling and offered empathetic responses in addition to pedagogy. The control condition was exactly the same, except that the characters skipped asking the student about their emotions and proceeded directly to offering exposition.

The first of two studies was conducted with middle school students, then the second replicated the findings with high schoolers (McQuiggan et al., 2008b). Because there were no differences in reported empathy or presence between populations,

McQuiggan and his collaborators combined the two and observed a strong significant effect of empathetic characters on presence ($p < .01$). The results were the same for both populations when examining the impact of empathetic characters on involvement and control as well. When combined, the effects were strongly significant once again ($p = .0005$). Participants reported considerably more presence, involvement, and control in the empathy condition, conceivably as a result of empathetic characters. Additionally, middle school and high school students who described themselves as empathetic (high score on the Interpersonal Reactivity Index) reported significantly greater presence when interacting with empathetic characters. Once again, combining the two populations enhanced the effect. The findings of this investigation support the hypothesis that empathetic characters positively impact the player experience in multiple ways. It was notable here how the only difference between the empathy condition and the control condition was the characters asking how the player was feeling, and responding empathetically. Empathy may be an important aspect of the link between a player and the immersion they experience in a game.

Studies suggest that we interact with virtual agents in much the same way as we interact with real people. In one study of virtual humans (Johnsen, Raij, Stevens, Lind, & Lok, 2007), there was a significant correlation ($r(33) = .49, p < .005$) between the way in which medical students interviewed virtual patients and how they interviewed human actors trained to portray patients. A virtual storytelling environment called *FearNot!*, which stands for Fun with Empathic Agents Reaching Novel Outcomes in Teaching, made use of this human quality of virtual agents by applying it to anti-bullying education (Aylett, Louchart, Dias, Paiva, & Vala, 2005; Paiva et al., 2004). The goal of this project was to design virtual dramas acted out by 3D characters to teach the

UK curriculum "Personal and Social Education," which deals with topics such as bullying, racism, drugs, and sex education. *FearNot!* presents a third-person scenario to students in which they can witness emotionally-charged bullying events (Paiva et al., 2004). Characters are designed to be believable in the empathy they show toward other characters and the empathetic responses they trigger in users. In *FearNot!*, dramatic episodes are interspersed with periods in which the audience can offer advice to the characters. The developers believed it was important for the empathetic relationship that the students feel that the characters are taking their advice seriously and acting upon it (Aylett et al., 2005; Paiva et al., 2004), so they designed the system such that characters act autonomously in response to the players' recommendations. The authors explained:

The creation of an empathic relationship between child and character was seen as the mechanism through which this sense of responsibility would be achieved, so that the child user would really care what happened to the victimized character. The child was asked to act as an 'invisible friend', and to give advice which would influence the behaviour of the victim without undermining its autonomy of action and the child's ability to believe in it as a character with an independent inner life. (Aylett et al., 2005, p. 2)

This emergent narrative structure will be discussed in more depth in the following section. In an initial evaluation of students' perceptions of these characters (Paiva et al., 2004), 86% said they felt sorry for one of the characters (generally the victim) and 72% said they felt angry at one of the characters (generally the bully). It appeared from this initial survey that virtual agents could indeed be capable of eliciting empathetic responses in players in a learning environment.

The idea of virtual peers as companions to learners has also been raised by researchers. Ryokai, Vaucelle, and Cassell (2003) inquired whether virtual peers could be effectively utilized in storytelling for literacy learning for preschoolers. They

explained the importance of peers as equal-status partners who provide scaffolding and modelling to each other in developing their language abilities. In Ryokai et al. (2003), a virtual agent by the name of *Sam* was designed to be a learning companion to students, with the appearance of a child of around age 6 and an androgynous look in order to appeal to both boys and girls. This character tells the child stories and listens to their stories as well, creating an interactive game-like experience. *Sam* is designed with Vygotsky's zone of proximal development (1978) in mind; she speaks in a more advanced form than the child, and her developers hypothesized that by interacting with her, the student would model *Sam*'s linguistic behavior. In this study, 28 five-year old girls volunteered to play with *Sam*. The children took turns with the virtual character in telling stories. Researchers coded the stories children told, looking for instances of particular expressions and patterns of speech. A full-factorial ANOVA showed that the presence or absence of *Sam* had a main effect of $F(3,24) = 68.04$ ($p < 0.01$) on children's use of quoted speech and spatial and temporal expressions. While the study was too short to conclude that participants learned these expressions from *Sam*, it did suggest that this virtual agent may have given children an opportunity to practice more advanced forms of language. Additionally, the children reacted positively to *Sam* and seemed to regard her as a storytelling partner. It appeared from these observations that not only did a virtual character seem to enhance student immersion in a learning environment, but she also may have supported learning goals through her social aspects.

Adaptive and responsive storytelling.

According to the literature, learners may also be more compelled by stories that are personalized to them. Returning once again to Malone and Lepper's (1987)

taxonomy, *control* may factor in to why adaptive and responsive narratives are appreciated by game players. Students in a narrative-centered learning environment may feel a heightened sense of agency and freedom when their decisions impact the outcome of the narrative (Rowe et al., 2007).

Artificial intelligence (AI), which is steadily gaining prominence across the educational landscape, could play a sizable part in how responsive learning environments can be created in future projects. For example, Mateas and Stern (2005) produced a high-agency, responsive interactive drama called *Façade* using AI. The authors described how agency is often thought of as "the holy grail of interactive story" (Mateas & Stern, 2005, p. 5) because it gives players control over the structure of the entire experience. However, it is also highly challenging to implement because it necessitates technical systems that can be receptive to the actions of the player. One advantage of this approach to narrative is that replay is more desirable (Mateas & Stern, 2005).

While Mateas and Stern (2005) only designed *Façade*, but did not evaluate it, another group of researchers conducted an empirical study to test player reactions to their interactive drama created with AI. A paper by Thue, Bulitko, Spetch, and Wasylishen (2007) presented a system for developing interactive stories called *PaSSAGE* (Player-Specific Stories via Automatically Generated Events) that uses a branch of AI known as player modelling to learn about how the player likes to play, then applies that information to determine how the story will be presented to them. They performed a mixed-methods study that included both a qualitative case study of *PaSSAGE* and an experimental user testing study of a game created with the system. In the user study, the authors evaluated *PaSSAGE* in terms of two hypotheses: 1) an adaptive story is

more entertaining than a fixed story; and 2) the player feels greater agency in an adaptive story than in a fixed story. The authors created 8 encounters for a "Little Red Riding Hood" interactive narrative (e.g., call to adventure, road of trials) and mapped them onto particular styles of play in a game tree. One story was adaptive and the other was fixed. Player responses to a "history lesson" (p. 46) at the beginning of the game were used to generate a model of the player. Ninety university students played the game (either fixed or adaptive) then rated their experience across dimensions like entertainment, replay value, interest, and creativity. Confidence levels indicated that females who found the game easy to follow enjoyed the adaptive game more and felt more agency than the players of the fixed version. Players of the adaptive version who traversed one of the fixed paths and found it easy to follow also enjoyed the adaptive version more. Results suggested that certain player types can find a greater enjoyment and sense of control in adaptive stories.

FearNot!, described above, also demonstrated success when it exposed its users to adaptive storytelling for anti-bullying education (Aylett et al., 2005). A key component of this program is emergent narrative a story that is unscripted and emerges from a flexible, real-time experience. The creators of *FearNot!* used an "appraisal-driven agent architecture" (Aylett et al., 2005, p. 305) to generate it. In emergent narrative, authoring is kept to a minimum; the author sets up the story and characters with background information, but the development of the story itself is determined by artificial intelligence. In a small-scale evaluation of the program, eleven 3rd and 4th graders in a Portuguese school participated individually. Compared to the scripted version, students found conversations to be more interesting and the characters more believable.

A Wizard-of-Oz study of *Crystal Island* (Lee, Mott, & Lester, 2010) made it apparent how different students can interact with a game story in a variety of ways, which may warrant a more individualized approach to narrative in serious games. One strength of a Wizard-of-Oz study design, here, was that it left interactivity in the hands of a human confederate (referred to as a "wizard") rather than a complex technical system. This way, researchers were able to explore what an ideal narrative-centered learning environment might look like in terms of responsiveness, without being limited by what was technologically possible at the time. In this study, narrative profiles of students were produced by examining how they progressed through the game story. Wizards worked with learners as they solved the science mystery and dictated how the narrative events would unfold by triggering them on a *narrative dashboard*. Thirty-three middle school students completed a pre-test, collaborated with the wizard on *Crystal Island*, then took a post-test. The narrative profiles created were defined by the time players spent in five phases of the narrative (exposition, complication, escalation, climax, and resolution). Learning gains were found across two clusters of students, but Cluster A performed higher on a post-test than Cluster B. Cluster A spent more time on data collection, science reading, and inquiry during the climax phase; Cluster B completed these activities during the complication and escalation phases. This type of knowledge could hopefully be used to "[optimize] story-based learning" (p. 156) in serious games.

All learners and all game players are different. A new wave of artificial intelligence research showed that narratives have the potential to be highly adaptive and responsive to both the desires and learning needs of individual students. This

capability of adaptive narrative could be especially helpful for learners in need of scaffolding to better understand the material.

This literature review has covered both the primary roles narrative appears to play in the learner experience in a serious game and some of the qualities that have been associated with successful game narratives. In the next chapter, the findings that have been presented here will be considered within the context of a serious game called *Alien Rescue*.

Chapter 3: Mini-Case Analysis of *Alien Rescue*

In this chapter, the findings from Chapter 2's literature review will be applied to an example of a narrative in an existing serious game, *Alien Rescue*.

Overview of *Alien Rescue* Learning Environment

Alien Rescue is a problem-based hypermedia learning environment for sixth-graders learning space science (Liu, Williams, & Pedersen, 2002). The program is designed in keeping with the National Science Standards as well as the science Texas Essential Knowledge and Skills (TEKS). In this game, learners navigate through an interactive virtual environment, gathering information in order to find suitable homes for six different alien species within our solar system. These relocations on our planets and moons must take into account the requirements the alien species have that are necessary to their survival, such as temperature ranges or the absence of seismic activity. Students have cognitive tools like a periodic table and a notebook as well as databases of scientific information at their disposal as they engage in solving this complex problem within a meaningful context. They can also design flyby, orbiter, and lander probes and send them to planets and moons to collect more data.

The narrative of *Alien Rescue* is a science-fiction, fantasy tale that centers around an interstellar drama. Students step into the shoes of scientists aboard the Paloma International Space Station who have received a message from six alien species--the Akona, Eolani, Jakala-Tay, Kaylid, Sylcari, and Wroft--seeking asylum in our solar system. A rich backstory for the circumstances under which the aliens found themselves in this predicament is presented to the learner: after their home planets were destroyed by an exploding star, an accident during their voyage damaged their ship, leaving them

stranded. Now, these aliens are relying on learners, "expert" scientists who have been chosen to guide these beings in their search for new homes.

Applying Findings from Literature Review to an Enhanced Narrative

Lessons from existing serious games.

The *Alien Rescue* program bears resemblance to a number of serious games evaluated in the aforementioned studies on game narratives. Like *Crystal Island* and *Quest Atlantis*, and to a lesser extent *Murder on Grimm Isle*, *Alien Rescue* is a virtual environment for inquiry-based learning (Liu, Horton, Olmanson, & Toprac, 2011). The key element common to all of these games is that students gather evidence and craft an argument to solve a problem. Despite the games' differences in theme, genre, and setting, this shared purpose ties all three together, suggesting features that have been effective in one game would likely prove successful in the next.

A collective theme from these games is that narrative is not located in one place, but rather, is distributed across the ILE through environmental storytelling (Truby, 2008). Currently, narrative in *Alien Rescue* is primarily located in the Alien Information Center, which tells the story of the aliens' journey and the accident that befell them, as well as backstory on each individual species. In *Crystal Island*, by contrast, bits of the story can be pieced together from objects such as posters in the camp buildings or books in the library (Rowe et al., 2011). The developers of *Alien Rescue* could adopt this strategy by embedding information pertaining to the core narrative of the game in computer monitors in the space station, posters on the wall, or other props in the 3D environment. Barab and colleagues (2007) described how *inscriptions* such as diagrams, tables, and charts, are used in *Quest Atlantis* to extend the narrative. For example, a handwritten scroll is left on the ground for students to stumble across in the game, and

this artifact gave students in their classroom study an opportunity to debate with one another and compare their interpretations of its meaning. Another benefit to inscriptions was that they encouraged students to make connections back to the Taiga population they were studying and the underlying socio-scientific narrative. *Alien Rescue* could follow this pattern by exposing students to relics from alien civilizations. For example, according to the game story, the Sylcari species build their habitats out of a coral-like animal called "melk" (described in the passage in Figure 1).

Figure 1

A paragraph in the Alien Information Center describing the habitat and dwellings of the Sylcari species

Instead of encountering this bit of narrative by reading through the database, learners could find a blueprint of a Sylcari shelter, learning about its building materials and

constituent parts. This artifact could be imbued with narrative as well as the pedagogical content knowledge students need to solve the problem of alien relocation. Currently, the narrative in the Alien Information Center requires students to read through a series of paragraphs about each species' communication, food, technology, and the worlds they inhabited in their own solar system. Instead, distributing the narrative across multiple channels or formats using inscriptions and artifacts could reduce the cognitive load on students posed by the large blocks of text.

Crystal Island makes use of Malone and Lepper's (1987) four intrinsic motivators: challenge, curiosity, control, and fantasy. Evidence of intrinsic motivation is already present in a case study of the program by Liu, Toprac, and Yuen (2009); student interviews revealed that *Alien Rescue's* authenticity, challenge, cognitive engagement, competence, choice, fantasy, identity, interactivity, novelty, sensory engagement, and social relations motivated learners. However, these elements were observed in students' reactions to the entire problem-based learning environment rather than the narrative alone. It is possible that intrinsic motivation could be reinforced with motivating storytelling elements inspired by Malone and Lepper (1987), as depicted in the table below. The storyline of *Alien Rescue* does not consist of narrative *events*, per se, but structuring the narrative in this way may help developers reveal smaller pieces of information to the learner at a time.

Table 2

Malone and Lepper's (1987) taxonomy of intrinsic motivators and their proposed application in Alien Rescue

Intrinsic motivator	Key points from Malone and Lepper's (1987) taxonomy	Proposed application in <i>Alien Rescue</i> game narrative
<i>Challenge</i>	Tasks that have the optimal level of challenge (not too easy or too difficult) will be maximally motivating for students.	As a supplement to pedagogical goals that already exist, incorporate narrative goals (tasks that reveal information or advance the plot) as well. For example, a successfully launched probe could uncover a fact about the alien ship's computer being powered by the Akona species.
<i>Curiosity</i>	Discrepancy between the students' current knowledge and skills and the expected knowledge and skills as an outcome of the activity maintains the interest of students.	Refrain from revealing all information about the accident and the backstories of alien species upfront. Just as information about planets and moons is left intentionally incomplete for the purpose of inquiry, leave gaps in information about the aliens so that students want to learn more about their species and the entire narrative.
<i>Control</i>	Students are more motivated when they experience a sense of power and choice over learning.	Make the sequence in which narrative events are presented more dependent upon the decisions students make. Aliens could also ask for help from students at different times, varying their in-game experience (e.g., a member of the Jakala-Tay clan could elicit help from 6th grader Raquel because she found an artifact from their civilization in the space station, which triggered this narrative event).

Table 2 (continued)

<i>Fantasy</i>	It is motivating for students to imagine and build mental models of situations outside of reality. Fantasies can also provide access to the other three motivators, even if they are not present in real life.	In descriptions of the aliens' experience, use vivid imagery associated with space exploration and unknown planets and worlds to convey the mysterious, fascinating nature of the universe. Include details about the player character's professional title, duties, etc. to allow learners to step into the shoes of a scientist or astronaut and become immersed in the life of their imaginary persona.
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Narrative techniques and frameworks.

Game Discourse Analysis (Wouters et al., 2011) is one method from the literature that developers could apply to pique students' curiosity and enhance their immersion in *Alien Rescue*. Foreshadowing and backstory could be used to create gaps in information that leave students wanting to learn more about the narrative. According to Park et al. (2010), showing a trailer to users before they played a game increased both their positive evaluations of it and their reported presence. Before students begin *Alien Rescue* in classrooms, teachers typically play an opening video for them that relays the scenario of the game. First, an alien spacecraft is seen hurtling through the galaxy, then newscasters dramatically cover the "breaking news" story of alien life forms arriving in our solar system seeking new homes. A short message from the aliens asking for assistance can also be heard emanating from the space ship. One possibility for greater immersion might be to embed this short film into the game as an introductory cutscene. Alternatively, this opening video could employ more of the foreshadowing and backstory characteristic of Game Discourse Analysis. For example, this scene could take

the form of a personal solicitation for help by a member of one of the alien species that creates backstory through a brief history of the experiences of their civilization. The trailer shown to students could also use foreshadowing to reveal small snippets of information that students will later encounter to incite their curiosity.

To boost student motivation in *Alien Rescue*, the author recommends applying the Narrative Centred Informant Design (NCID) framework outlined by Waraich and Brna (2008). The NCID framework is user-centered and deems the target audience "informants" to the design process. The graduate students responsible for the development of *Alien Rescue* partake in regular school visits to classrooms using the program, interviewing users on camera. When the research team conducts these informal interviews, it seems that students have many ideas for what they would like to see in the game. In keeping with the NCID method, 6th grade students, representative users of the program, could be consulted about decisions related to the narrative. Developers could even go as far as to poll a focus group of adolescents about what kinds of characters or plotlines they would like to see added to *Alien Rescue*. Questions asked might include "Would you like it if there were a villain in this game?" or "How would you feel about adding humor?" Consequently, story elements attractive to 6th graders could be utilized and undesirable ones avoided.

Effective game narrative features.

Endogenous fantasy and intrinsic integration.

According to Malone (1981), fantasy that is intrinsic to gameplay will be more likely to lead to transfer. In *Alien Rescue*, pedagogical content, gameplay, and narrative are inseparable; one cannot exist without the other. The fantasy in this game is highly endogenous, as learners participate in a fantasy narrative about aliens and planets in

order to study space science. Because the core game mechanics (e.g., exploring space, learning about the solar system, sending probes to planets) are entirely dependent on the fantasy content, it also fits Habgood and Ainsworth's (2011) definition of a game that is *intrinsically integrated*. If the results of their study generalize to other populations such as middle schoolers, the intrinsic integration in *Alien Rescue* is likely to benefit both students' motivation and their learning in the program.

One possible way of boosting this effect could be to make the learning tasks themselves more intrinsically integrated within the science fantasy narrative. Habgood and Ainsworth's (2011) work with *Zombie Division* suggested that pedagogy can be tightly woven into core gameplay, as students playing the intrinsic version made mathematical computations through combat itself. In the way that training tasks are portrayed as the player inventing machines in *Braingame Brian* (Prins et al., 2013), students' inquiry and learning tasks in *Alien Rescue* could be more concretely connected to the fantasy. Middle school participants in the study of *Crystal Island* by Rowe et al. (2007), for instance, expressed interest in "mini-games" that would relate to pedagogical content in the game. In *Alien Rescue*, a "mini-game" could be created from the Missions Database content in which the player arranges a small space history museum exhibit on board the space station to commemorate the NASA missions. A task such as this would blend pedagogy, gameplay, and fantasy narrative together in a strong intrinsic integration. Probe Design could also take on a similar form, with students witnessing the player character physically constructing probes to send to planets and moons in a workshop on board the space station, allowing them to imagine themselves more vividly within the science fantasy narrative. Even the Solar System Database, containing information about planets and moons, could be merged more seamlessly into the

fantasy if students could access it by looking through a telescope. In these interactive simulation-like tasks, learners would be exposed to the same scientific data but through the lens of the space-themed fantasy, which could possibly increase their motivation.

Empathetic characters and virtual agents.

In the latest iteration of *Alien Rescue*, released into classrooms in May 2018, a new character was introduced--a robot named B3VO. The introduction of this non-player character served a functional role, to orient the student in the game environment and replace the Communication Center, a console which had previously provided students with access to a message from the aliens and a location to submit a recommendation on where to place alien species in the solar system.

Figure 2

B3VO, a non-player robot character added to the latest iteration of Alien Rescue to replace the Communication Center

In light of the results of the empathetic virtual agents study described in the literature review above (McQuiggan et al., 2008b), it seems that a simple modification to B3VO could impact students' presence, a subdomain of immersion. Like in the study, B3VO could ask players how they are feeling and respond empathetically. A variety of randomized responses for each category of student answer ("good," "bad," etc.) could give the learners a sense that their response from B3VO is somewhat unique and personalized to them.

Table 3

Proposal for B3VO's empathetic responses

Student's reported emotion	B3VO's empathetic response
Good	<ul style="list-style-type: none"> • "That's great to hear!" • "Excellent! Let's get to work."
Bad	<ul style="list-style-type: none"> • "Sorry to hear you're feeling lousy." • "That's too bad. Maybe conducting some scientific research will help you feel better!"
OK	<ul style="list-style-type: none"> • "I have days like that too." • "Did you wake up on the wrong side of the space station?"
Confused	<ul style="list-style-type: none"> • "If you're feeling stuck, I wonder if you could ask one of your fellow scientists for a hand?" • "Maybe you could try gathering more data about the aliens and planets."

Although asking students about their emotions might appear like a waste of valuable learning time upon first glance, McQuiggan et al.'s (2008b) results spoke to the strong effect this minor supplement to a game narrative could potentially have on their presence in the game environment.

Additionally, aliens could shift from being conceptualized as entire populations to individual characters--members of each species with whom the player could interact. As dialog and rich conversations with characters have been found to spark curiosity and motivation in learners (Rowe et al., 2007), students in *Alien Rescue* could interview the aliens directly to gather information about their home planets and the requirements of their species. As students forged empathetic relationships with these intelligent beings in this way, understanding their dilemma more deeply, they might experience greater immersion than they currently do reading about the aliens from a secondary source (McQuiggan et al., 2008b). Like researchers found in their mixed-methods study of *Quest Atlantis* (Barab et al., 2007), interviewing stakeholders could help humanize the scientific content of the game for students, exposing them to ethical considerations surrounding this discipline. As illustrated by the *FearNot!* program (Aylett et al., 2005), if the user believes their advice is impacting the character, this can strengthen the empathetic connection between them. This tenet suits the existing narrative of *Alien Rescue* quite well, as aliens are thought to take the recommendations of learners on which planet or moon to inhabit. This could be made more evident through animations, videos, or even text sent from the aliens to the student, thanking them for their relocation guidance. Finally, the *Sam* study by Ryokai et al. (2003) indicated that virtual characters in educational programs may be able to model sophisticated language for learners. Vygotsky's (1978) zone of proximal development could inform the speech patterns of characters in *Alien Rescue* as well; when aliens are interviewed, they could use scientific language slightly beyond sixth graders' familiarity to encourage them to build upon their scientific vocabulary. One limitation of allowing students to interact

directly with aliens would be the need for either some minimal 3D animations or 2D representations of these characters to use in dialogs.

Adaptive and responsive storytelling.

As a program developed entirely by graduate students at The University of Texas at Austin, there are significant limitations on the extent to which artificially intelligent systems can be incorporated into *Alien Rescue*. The approach used to create *Façade* (Mateas & Stern, 2005) was highly technical and required a long development time, so this method would not be practical for iterations of *Alien Rescue* in the near future. The player modelling system *PaSSAGE* (Thue et al., 2007) may be closer to a feasible application because student data is highly accessible and already being used in *Alien Rescue*. Learners could be categorized according to their style of play in the game environment (e.g., explorers, readers, probe launchers), determining the sequence of narrative events and thereby increasing the sense of agency that students feel.

The method of adaptive storytelling used by Lee et al. (2010) may be the most practical for potential applications to *Alien Rescue*. The narrative profiles they created of students were entirely based upon the time they spent engaging in particular tasks in the game. This data is readily available. Developers of future iterations of *Alien Rescue* could analyze how much time students spend in various databases or rooms of the space station, such as the Concepts Database or Probe Design, and use it to govern which narrative events are triggered at certain times. Particularly, this type of responsiveness could serve to provide scaffolding to students struggling with the material by 1) recognizing their need for help and 2) offering it in the form of relevant narrative events.

Chapter 4: Discussion and Implications

This paper opened by posing narrative as a tool for greater meaning-making in learning environments. The research questions of this study were presented in Chapter 1. To answer the first research question regarding the role of narrative in the experience of serious game players, findings from empirical studies were examined. Relationships were found between serious game narratives and: immersion, engagement, motivation, and learning gains. Many of these studies considered whether the existence of a strong narrative made an impact on player experience. Next, this paper drew from research on specific features of game narratives to speak to the second research question.

Endogenous and intrinsically integrated fantasies, empathetic characters and virtual agents, and personalized narratives (adaptive or responsive) were three potentially powerful storytelling features that arose from the data.

The final research question asked how these findings could improve the narrative of the virtual problem-based learning environment *Alien Rescue*. Firstly, it was suggested that the narrative of *Alien Rescue* be broken up into smaller units and distributed across various locations in the game in the style of *Crystal Island*, *Quest Atlantis*, and *Murder on Grimm Isle*. These could be presented to the learner in "narrative events," sequenced in a way that promotes challenge, curiosity, control, and fantasy (Malone and Lepper, 1987). It is recommended that Game Discourse Analysis (Wouters et al., 2011) be used to stimulate student curiosity through foreshadowing and backstory in the introductory video that is shown before learners begin the program. Through Narrative Centred Informant Design (Waraich & Brna, 2008), 6th graders could share their insights on the kinds of game stories they enjoy and even contribute to writing narrative components like characters and plotlines to be used in *Alien Rescue*.

Alien Rescue is already a highly endogenous fantasy, but greater intrinsic integration might be achieved through "mini-games" that embed inquiry learning tasks in the fantasy. A small but meaningful addition to B3VO is proposed: empathetic responses to the player's reported feelings. Rather than being represented as entire groups, aliens could be introduced as individual members of their species--characters with whom students could converse to learn about their needs. Player modelling or narrative profiles are two possible methods of tailoring narrative sequence to the individual student and offering scaffolding through the story to students in need of help.

Though the serious games sampled in Chapter 2's literature review all contain some element of story, their diverse purposes and target audiences may make their results difficult to generalize to the middle school science context of *Alien Rescue*. One additional limitation posed by these narrative suggestions for the program is that it *Alien Rescue* is designed to fit into a prescribed time period for classroom use: around fifteen 45-minute class sessions (Liu et al., 2002). Narrative "events" and increased student exploration in the space station could lengthen the time it takes them to find solutions, compared to heading straight to the Alien Information Center for a needed piece of narrative. It is with these caveats that these recommendations are presented.

Areas for Future Research

There are many reasons to continue this line of investigation into how narrative functions in a serious game. Compared to advanced gameplay mechanics, sophisticated CGI, and other technical capabilities, narrative is quite inexpensive. Considering how Parker and Lepper (1992) discovered that even simple narratives produced a large impact on motivation, narrative could be a formidable tool in a serious game

developer's arsenal for increasing the usage of a product and improving learner outcomes. Accordingly, McQuiggan et al. (2008b) advocated for shifting the focus of research from technological and interface methods of increasing presence to content methods. Future research on serious game narratives should examine more closely which precise aspects of narrative are beneficial to learners. Additionally, interdisciplinary studies and applications of newer research methodologies will be necessary to gain a more nuanced understanding of the diverse ways in which narrative works in a serious game.

Interdisciplinary studies.

Despite many studies showing the effectiveness of serious games in promoting learning, there is still an existing divide between the games industry and education (Westera et al., 2008). Furthermore, the vast array of disciplines sampled in this review is a testament to the need for greater intersections of academic fields and collaboration between researchers and practitioners. Although there are copious differences between the design and development of commercial games and serious games (Mildner & Mueller, 2016), the experience of the player is a crucial point of interest in both arenas. Overlap in this topic can be used to inform those seeking to produce game-based learning programs and software.

Applying new methodologies.

In researching serious game narratives, academics could benefit from a foray into less conventional methodologies. User-centered methods such as design-based research, in particular, hold great potential to learn more about what attracts learners. The realm of educational technology is multi-faceted:

Technology is much more than hardware. It is a process that involves the complex interactions of human, social, and cultural factors as well as the

technical aspects...it requires new directions in research goals, moving away from traditional predictive methods to long-term collaborations based on development goals. (Amiel & Reeves, 2008, p. 31)

Amiel and Reeves (2008) proposed design-based research as a method of determining in what ways technology can make greater strides in the area of education. The authors stated their belief that it is highly important that future research on educational technology be conducted hand-in-hand with practitioners who can elucidate what areas of research are truly valuable. Design-based research should be 1) interventionist, 2) iterative, 3) process-oriented, 4) utility-oriented, and 5) theory-oriented. It should take the form of a cycle of design-reflection-design in which design principles are integrated with technological advances, plausible solutions are considered, and rigorous testing is conducted to refine learning environments.

According to Waraich (2004), it is rare for developers of serious games to invite users into the design process, but this partnership is fundamental in order to create a product that will appeal to them. The Narrative Centred Informant Design methodology is one example of a learner-centered framework that can be used to design narrative-rich virtual ILEs (Waraich & Brna, 2008). Their approach resonates deeply with champion of "design thinking" Tim Brown's user-centered design philosophy (Brown, 2009). In *Change by Design*, Brown offered three essential tenets to putting people first: insight, observation, and empathy (Brown, 2009). These thinkers advocated for a bridge between designers and consumers and an emphasis on allowing the user to actively participate in the design process.

Serious game narratives can provide meaningful structures to learning that are frequently quite memorable. Who could forget the globe-trotting art thief in *Where in the World is Carmen Sandiego?* or the perilous adventures that took place in *The Oregon Trail?*

In the words of Mark DeLoura (2001), “Given that games can teach people, why aren’t there more fun educational games available?...As an industry, we could be making games which take the boredom out of school for the next generation of students” (p. 6). Story is far more than simply an add-on to serious games, but an integral piece of the puzzle when creating an immersive, engaging, and motivating learning experience.

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This manuscript was typed by the author.