2014

The Effects of Narrative and Achievements on Learning in a 2D Platformer Video Game

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THE EFFECTS OF NARRATIVE AND ACHIEVEMENTS ON LEARNING IN A 2D PLATFORMER VIDEO GAME

by

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A dissertation submitted in partial fulfillment of the requirements
for the degree of Doctor of Philosophy in Modeling and Simulation
in the College of Engineering and Computer Science
at the University of Central Florida
Orlando, Florida

Fall Term
2014

Major Professor: Rudy McDaniel

ABSTRACT

Game design is a rigorous practice rife with complexity. The design of learning games is similarly complex to the design of their entertainment-based relatives. This complexity is partially due to the many interacting components that comprise games. The impacts of these individual components are not well understood. Advancing the understanding of how such component parts contribute to the formed game will inform decisions related to their inclusion and subsequent design within games. Achievements and narrative are two such components. They have been examined within gamified systems, but little research has studied them within the context of a serious game. The interactions between such elements and other game elements could produce results that diverge from the results of their use in isolation of a complete gaming framework. This dissertation selectively incorporates or excludes narrative and achievements within a two-dimensional platformer serious game to understand their impact on learning, flow, engagement, narrative transportation, and intrinsic motivation. Conditions are examined individually as well as in a combined condition. A control condition is maintained for comparison. Results indicate that narrative and achievements were not effective in improving the effectiveness of the game. Potential causes are discussed in tandem with the implications for the design and integration within a gaming framework. While the manipulations did not improve effectiveness, the game was responsible for substantially increased knowledge acquisition, as determined by pre and posttest results.

ACKNOWLEDGMENTS

I am fortunate to have had such a high level of support in my educational journey and throughout the creation of this dissertation. I'd like to begin by thanking Julie Salcedo, Javier Rivera and Corina Lechin for their support in the formation of the preliminary concept of Medulla. I'd also like to thank Kristal Cazella and Peter Staffa for creating the art for the green and purple enemies.

Thank you to my committee members, Rudy McDaniel, Peter Smith, Clint Bowers, and Stephanie Vie for providing me with the committee I had always hoped I would have at this stage in my education. As a team, they helped me write clearly, think deeply, consider possibilities, and remain calm and confident throughout the dissertation process.

I would like to provide a special thank you to Rudy McDaniel who provided me with more opportunity than I could have imagined. I would not be the academic I have become if it was not for his willingness to let me fail gracefully and subsequently guide me toward understanding and improvement. Beyond that, he enabled me to conduct a dissertation on the topic of my dreams, allowing me to be independent while still nudging me in the right direction whenever I began to veer off course.

Thank you to all of my UCF TKD friends. It's been a long road since I met most of you, circa 2005, but you have all helped me enjoy my time at UCF over the past decade. Beyond that, your influence has developed me into the person I am today.

However, I would not have made it this far without my family. Thank you to my mother, Donna, for pushing me ever-harder, frequently at her own expense. Without her, I never would have realized my potential and continued to push past my perceived limitations.

Thank you to my father, John, for his words of wisdom that have guided me since I was a child. Beyond that, his lightheartedness has always reminded me to work hard, but never stop enjoying life. This has taught me to have balance in my life so that my spirits remain high and I am always able to accomplish my goals.

Thank you to my brother, Shane, for being both a supportive family member and a friend. Sitting around the table and talking video games with him puts me in a calm and comfortable space that helps me to refresh my thoughts and energy. Throughout the dissertation process, his interest in hearing about Medulla was both motivating and insightful as it helped me to deeply consider the game's mechanics while generating new ideas.

I would especially like to thank Kristen for her supportiveness and tolerance on a day-by-day basis during this dissertation process. I could not have picked a more perfect person to help me deal with the daily stresses and frustrations inherent in graduate school. I would like to thank Kristen for listening to my stories, offering genuine advice, and selflessly spending time and effort to make sure I was always happy. Because of her, I knew that I could handle whatever life threw at me and that everything would always be ok.

Thank you to everyone I have mentioned, and to all of those whom I have now run out of space to mention. This journey was not made in isolation, and I look forward to the next one.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ACRONYMS/ABBREVIATIONS

FSSS	Flow State Short Scale
IMI	Intrinsic Motivation Inventory
NPC	Non-Playable Character
UCF	University of Central Florida

CHAPTER ONE: INTRODUCTION

The idea of using games for educational tools is far from novel. There are countless historical examples. Similarly, the question of whether games are effective tools for teaching has also been asked and answered. Games have proven to be capable of serving as effective teaching tools (Boeker, Andel, Vach, & Frankenschmidt, 2013; Ferdig, 2009). A meta-analysis of 32 studies reported significantly higher cognitive gains and better attitudes toward learning for games and interactive simulations over traditional teaching methods (Vogel, et al., 2006). This dissertation attempts to move beyond the simple question of whether games can teach and instead inquires *what makes games teach?*

Although games have been shown to be capable of being effective learning tools, like many mediums, they do not always succeed in their purpose. While many have successfully promoted learning, others have been ineffective (Girard, Ecalle, & Magnan, 2012). What is the cause of this variability? Gee (2003) states that all "good games" (p. 1) are learning systems and that these games contain learning principles that could be used to teach academic subjects. What, then, makes a good game? Games are complex systems, and learning is an equally, if not more, complex phenomenon. Teaching, the medium between which a tool transforms into learned content, is still being developed as a discipline, despite being a discipline as old as history itself. An essential question then becomes, *how can these highly complex areas best be wrapped into one neat package that is the good educational game?*

This dissertation follows that question, submitting information to a growing body of research that is attempting to understand how to effectively design educational games. However,

before defining the future of the field, this dissertation will pause to identify its relevance in history.

History

While the formal study of games as educational mediums is relatively new, games have been long considered for this purpose. In 1693, renowned philosopher John Locke stated:

> [When teaching a child] great care must be taken that it never be made a business to him, nor he look on it as a task… I have always had a fancy that learning might be made a play and recreation to children; and that they might be brought to a desire to be taught, if only learning were proposed to them as a thing of delight and recreation, and not a business or a task. (p. 148)

Yet, even then this was not a novel thought. Games have been used as teaching tools for millennia, usually in the form of military strategy games. The Japanese game of Wei Hai, circa 3000 BCE, required players to strategically outmaneuver their opponents in an attempt to gain a territorial advantage (Smith, 2010). Chaturanga, another military game, was developed in India around 500 BCE. As the middle ages approached their end, Chaturanga developed into the modern version of what is now known as chess (Riddler, 1998). More recently, famed English author H.G. Wells built, wrote about, and played war games.

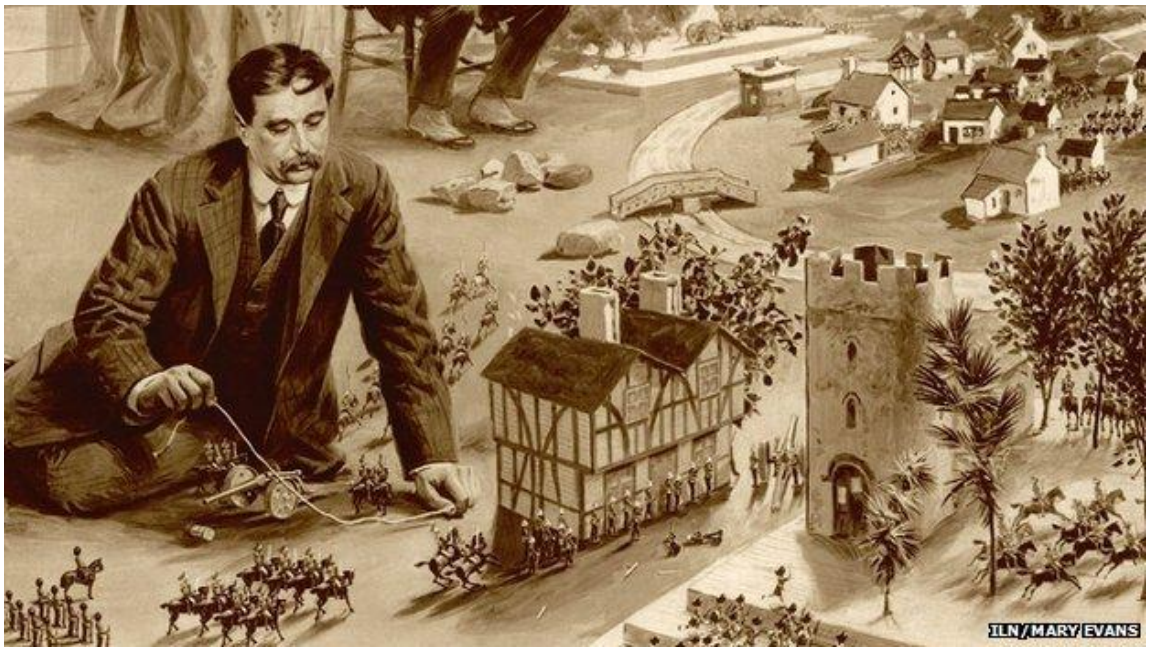


Figure 1. Illustration of H.G. Wells Playing a War Game (London News, 1913).

In modern society, we now have a host of games for education and training, ranging from those that have persisted through the years, such as chess, to games that suit more contemporary educational pursuits, such as *Reader Rabbit Preschool* (Graffiti Entertainment, 2011). Even Rovio (the development company behind the mobile hit *Angry Birds*) has begun developing games for education (Rovio, 2013). Educational games may be more relevant than ever, given the current pervasiveness of gaming in society.

Games in Society

Gaming has become an influential player in American culture, directly impacting the lives of over half of the country, with 58% of Americans playing games (ESA, 2014). Once

thought of as a hobby only for males (specifically, those classified as *nerds* or *geeks*), gaming has crossed the gender barrier now that 45% of all gamers are female. Further, it extends past the American borders, with global video game spending reaching $20.77 billion in 2012 (ESA, 2014) and the serious games market earning between $2 and $10 billion in 2012, depending on the definition of serious games and which applications are included (Hypergrid Business, 2012).

The implications of this widespread adoption are twofold. First, these statistics indicate a global interest in the technology. People enjoy games, even when they aren't providing anything beyond entertainment. Second, games are important to a great number of people. Gaming is no longer a niche hobby for a subgroup of males. In other words, gaming is an education boosting technology that can undergo widespread adoption because it is a familiar technology and has managed to lose much of its negative connotation.

A primary purpose of this dissertation is to make forward progress in educational game design, so that this familiarity and affinity with and for games can be leveraged, providing learning tools that are effective, enjoyable to use, and easy to learn. This dissertation will begin to dissect two elements in particular, narrative and achievements, and examines their effectiveness in fostering learning and motivation.

CHAPTER TWO: LITERATURE REVIEW

Clarification of Terminology

A review of the literature reveals no shortage of conflicting definitions for the terms "games," "serious games," and "training simulations." Without agreement, it becomes challenging to differentiate between these terms and set the scope of this dissertation. While games, training simulations, and serious games, in this dissertation, refer to those that utilize virtual environments, or interactive computer graphics-based displays that create an illusion of presence for the user (Schubert, Friedmann, & Regenbrecht, 1999; Ellis, 1994), this section seeks to establish more precise definitions that will be used as the foundation for the rest of this dissertation.

Games

As mentioned previously, there are several definitions for the term *game*, but Salen & Zimmerman's (2004) widely accepted definition will be central to this dissertation. In this definition, a game is "a system in which players engage in artificial conflict, defined by rules, that result in a quantifiable outcome" (Salen & Zimmerman, 2004, p. 80). The authors break this definition down into component parts to aid understanding:

A system is a collection of related parts that interact with one another in order to form an emergent whole. This is the basis for the rest of this definition. As players, artificial conflict, rules, and quantifiable outcomes become related and interdependent; a complete whole — the

game — is formed. A single part of the system is insufficient to constitute the essence of a game. Only as they merge does a game emerge.

Players describe the human actors within the game system. They are the ones who interact with the game. They follow the rules in order to resolve conflict and receive quantifiable outcomes based on their performance.

Artificial conflict, while traditionally thought of as human versus human, is not limited to these parameters. For instance, conflict can also include competition against artificially intelligent agents, or against some level of performance, either previously obtained by the self or another human, or artificially set by the developers (Charsky, 2010). Due to the existence of conflict, games always have winners and losers (Sauvé, Renaud, Kaufman, & Marquis, 2007; Ritterfield & Weber, 2005). While some would consider virtual worlds that lack competition to still be games, such as *Second Life*, this dissertation does not adhere to such a definition. Instead, it follows Salen & Zimmerman's definition. Additionally, the creators of *Second Life*, a 3D immersive virtual world, do not consider it to be a game, as "There is no manufactured conflict, no set objective…" (Kalning, 2007). These are differentiated as virtual worlds or environments which afford free play and are not game-based (Prensky, 2001), although the environment could be considered a sandbox which affords the spontaneous or planned emergence of games.

While this defines conflict, the "artificial" identifier cannot be forgotten. Artificiality delineates the boundary between games and the real world. It is widely agreed upon as a characteristic of games, and is sometimes referred to as "fantasy" (Charsky, 2010; Narayanasamy et al, 2006). Artificial elements may take the form of unrealistic environments

(e.g., a parallel universe), agents (e.g., vampires), behaviors (e.g., exaggerated affective responses), physics (e.g., double jumping), or other aspects and can provide context to the interactivity through the implementation of narrative-based elements (Quinn, 1996). In *Final Fantasy VII* (Square, 1997), the player may wonder why he or she is attacking so many people, or why so many angry characters seem to be surrounding the player's avatar. Once the player understands that the main character, Cloud, is from the rebel group AVALANCHE and is in the midst of setting explosives in the corrupt government's reactor, the player can understand why the enemy soldiers are reacting with such hostility.

The combination of these two terms describes a peculiar property of games, unnecessary challenge. Consider the game of 8-ball in billiards. The goal is to get all of your balls into the pockets before your opponent, ending with the 8 ball. Logic would dictate that the quickest way to do this is to pick up the balls with your hands and place them in the pockets as fast as you can. However, the game's rules dictate specific ways to achieve the goal, constraining the player to using a long stick, with a very small head, to strike the balls in the direction of the pockets, avoiding the opponent's balls in the process. Suits and Hurka (2005) describe that rules thus turn an inefficiency (using a long thin stick to strike balls into pockets) into a required action, if one wishes to play the game. If all games contain constraining rules, it then follows that games contain inefficient processes. Game playing is one of the few endeavors in which humans accept and execute inefficient actions to accomplish their goals. If you want to go to the store, you would probably hop in the car and drive there. You are unlikely to lie on your stomach and crawl down the street. Similarly, a basketball player would be much quicker if he could cradle the ball

and run down the court to the basket, but he or she chooses to follow the rules of the game and adopts the inefficiency of dribbling. Suits and Hurka (2005) describe this as the *lusory attitude*, which enables players to follow rules that require the player to use less efficient strategies or techniques than those that the player would use outside of the game's constraints. This attitude allows players to choose to embrace the existence of challenge in games.

Rules are responsible for creating challenge, defining the game's constraints and the structure of play, limiting the actions that the player can make while also defining those actions (Charsky, 2010; Salen & Zimmerman, 2004). In this way, the rules of the game also serve to facilitate achievement of the goal, defining the actions which can be used to progress (Smed & Hakonen, 2003). The inclusion or exclusion of rules is a key differentiator between games and non-game based free play (Prensky, 2001).

Quantifiable outcomes are produced in response to the player's performance during the preceding gameplay session. They may take the form of text, points, visual effects, or any of a number of feedback mechanisms that convey information about whether the player won, lost, improved, degraded, or remained stagnant during gameplay. In this regard, achievements or game-based badges may also serve as quantifiable outcomes.

Beyond Salen & Zimmerman's definition, games are also typically used for entertainment purposes, where the focus of the game is to promote enjoyment (Sussi, Johannesson, & Backlund, 2007). The player also tends uses some sort of handheld device or controller to play the game on a visual display (Alexander, Brunyé, Sidman, & Weil, 2005).

Digital Games vs Non-digital Games

This dissertation sets its focus on digital games. Digital games provide both unique capabilities and challenges that must be considered. Perhaps most importantly, digital games have the unique ability to exist in a virtual space, but receive interaction from a physical space. This has several implications.

While game design and development are expensive processes, the cost of creating a city in a physical space is infinitely more expensive and infeasible than creating it in a virtual space. Likewise, creation of complex scenarios and reactions are simpler, quicker, and more cost effective in a virtual space than the physical realm. Further, many situations are not replicable in the physical space. Creating a fantasy-based scenario in which the learner plays the role of a dragon that shoots fireballs at invading ogres is not possible in the physical realm to the extent that it is digitally. Thus, digital games provide greater flexibility and possibilities in game development than do non-digital games.

However, a major difference between digital and non-digital games is the way in which the player interacts. In physical games, the player typically interacts through a combination of gross and fine motor movements, with a great amount of muscle recruitment. Simply rolling dice requires the player to engage the muscles in the hands, wrists, and arms, while engaging the muscles of the core to maintain body posture. While some games, particularly those utilizing 3D cameras, require a greater amount of muscular engagement, the great majority of games do not fit this trend. In digital games, the player tends to use a greater amount of fine motor movements,

while limiting the amount of gross motor movements. Players are typically seated in a relaxed posture in a chair, while their fingers and wrists do nearly all of the work.

That said, humans are well accommodated to using their muscles, as they have been using them for physical-based activities since birth. Gaming in a physical space can feel more natural due to this reason, while digital gaming may prove to be more difficult for players who did not grow up playing digital games. While digital games afford the creation of a cost-effective and flexible learning environment, games in the physical space afford an interaction method that is more natural for a greater number of learners.

Relatedly, physical games afford physical immersion. In a board game, the player is located within the game's environment. The player rolls the dice, moves the pieces, and can reach out and touch other players. These same affordances are not present in video games. However, video games enable the possibility for narrative transportation, a deep cognitive and emotional involvement in the game's world—a fantasy world, in the case of games (Green & Brock, 2000). As a result of these differences, digital games and those based in the physical space both warrant independent study. Their differences have the potential to support variations in results, purposes, and design methodologies.

Focus is now brought to the qualities that define digital games, to set the scope for this dissertation. Salen and Zimmerman (2004) describe four traits that are commonly found in digital games, but are uncommon in other forms of games. They are:

1) Immediate but narrow interactivity —— Games are able to provide immediate feedback to the player(s). A player may press a button on the controller and the character instantly jumps.

Attacking an enemy instantly shows it recoil in response or plays an animation indicating its demise.

2) Information manipulation — Digital games are loaded with information that is consistently manipulated by the game. Even the visual aspects of games are rife with data containing the location and state of each pixel, constantly being manipulated as the screen is redrawn 30 or more times per second.

3) Automated complex systems — Digital games allow interactions that are tedious or otherwise impossible to occur in non-digital games. Examining a typical RTS (Real Time Strategy) game, one will identify hundreds of drones on screen, collecting resources. As they do so, a visual element is tied to the resources, constantly updating a counter. Upon hitting a particular number, the game will check a queue to see if the player has defined the creation of a new warfighter. If so, the system will reduce the counter, update the queue (removing the player defined warfighter), play an animation to indicate that the warfighter is being constructed, and then visually place the warfighter onto the screen, usually with some sort of recognizable audio cue.

4) Networked communication — While not all digital games contain networked communication, many do. Networked communication allows players to communicate via long distances, enabling a form of play that isn't usually possible in non-digital games. Most importantly, it introduces a new type of social interaction in which high quantities of players are able to play games with each other and share digital social spaces.

Training Simulations

A simulation replicates real-world conditions to create an artificial environment that facilitates the development of skills, knowledge, or experiences of a user (Hammond, 2004; Narayanasamy, Wong, Fung, & Rai, 2006). Conditions may include visual stimuli, physical controls, or others (Alexander, Brunyé, Sidman, & Weil, 2005). Training simulations are frequently implemented when conditions are too costly, hazardous, unethical, or difficult to replicate in the real world (Gredler, 1996; Bonk & Dennen, 2005). For instance, a soldier stationed in Alaska may need to be trained for an operation that will occur during an upcoming tour in the Middle East. Replication of the terrain, in the real world, would be impossible due to expense and logistics. Simulation can support this task at a much lower cost. Similarly, procedural training during a live-fire situation could be supported, by simulation, with no danger to the trainee.

Training simulations must accurately replicate real-world conditions, or at least those conditions that are essential to the acquisition of desired skills, knowledge, or experiences (Sauvé, Renaud, Kaufman, & Marquis, 2007). More specifically, the skills improved in a Virtual Environment (VE) must also be required and improved in the operational environment to ensure optimal performance. A marksmanship trainer with an extra tree in the distance may not make a difference. However, accurate simulation of bullet velocity and wind or bullet drop effects in long-range marksmanship would be essential.

Training simulations contain goals, sharing this trait with games. Also like games, simulations use goals to encourage progression, clearly outlining the requirements for success. Goals may or may not encourage motivation.

Some key distinctions exist between training simulations and games. Training simulations must be context-specific. The simulation should accurately depict the operational environment, agents, and conditions, whereas games may use imaginative scenarios (Charsky, 2010; Narayanasamy, Wong, Fung, & Rai, 2006). As previously mentioned, training simulations are used to develop skills, knowledge or experiences. Games do not have this requirement (Narayanasamy, Wong, Fung, & Rai, 2006). Further, games have rules, by definition. They are required to set the boundaries for play. Training simulations have rules by necessity. A simulation that allowed freedom for the trainee would better simulate real-life conditions, but hardware, software, and other limitations create rules. In a simulation that teaches covert training for military snipers, it is unlikely that the user would be able to construct a ghillie suit from local foliage, although this capability may exist in the operational environment. Lastly, whereas games include the element of competition, training simulations do not (Thurman, 1993). There are no winners and losers; there are only objectives that have or have not been completed.

Serious Games

Serious games implement interactivity for training and education purposes (Raybourn, 2007). They are distinct from, yet related to, games for entertainment. They can be seen as a subcategory of these games, created for explicit learning purposes (Johnston & Whitehead,

2009). Serious games implement a mixture of instructional and video game elements for purposes beyond entertainment (Charsky, 2010; Sussi, Johannesson, & Backlund, 2007), teaching knowledge or skills (Zyda, 2005). They attempt to improve intrinsic motivation for learning by introducing gaming elements (e.g., competition, goals, rules, fantasy, etc.) into the pedagogy. If students want to learn, and spend more time trying to learn, the learning effect should be amplified. Indeed, time on task can predict knowledge-based performance (Fisher & Ford, 1998). Equally important is the pedagogical structure. While proper implementation of gaming elements can improve motivation, the careful instantiation of well-established pedagogical strategies, clear and attainable goals, and difficulty levels that adjust to the learner's ability facilitate completion of learning objectives (Malone, 1981).

Serious games distinguish themselves from games in their point of focus. Serious games focus on elements of learning — identifying and accomplishing learning objectives through gaming. Games focus on pure entertainment, without any sort of explicit learning objectives (Sussi, Johannesson, & Backlund, 2007). Succinctly, a game is transformed into a serious game through the incorporation of learning objectives and sound pedagogical principles.

Serious games differ from training simulations in similar ways that games differ from training simulations. Distinctive gaming elements (e.g., competition, fantasy, etc.) are present in serious games, while absent from training simulations. Serious games have rules, by definition, whereas training simulations have rules imposed by other constraints. However, serious games and training simulations share a similarity in their primary goal. Both seek to outfit the user with advanced skills, knowledge, or experiences.

Gamification

Gamification is a recent term, only gaining widespread use within the last several years (Deterding, Dixon, Khaled, & Nacke, 2011). It is consistently defined as the implementation of game design principles in non-game applications (Deterding, Dixon, Khaled, & Nacke, 2011; Muntean, 2011; Helgason, 2010). The final product lacks the qualifications to be considered a full game, but implements elements of games to improve its present form, frequently attempting to better engage the user (Zicherman, 2011). Further, the definition implies an inherent additive property in gamification, where game elements are added to the base non-game application. Game elements are defined as those elements that are typically present in most games, contribute significantly to the gameplay in those games, and are "readily associated with games" (Deterding, Dixon, Khaled, & Nacke, 2011, p. 12). Thus, elements may include any of those previously defined within this dissertation. For example, while achievements can be viewed as *quantifiable outcomes*, and therefore features of games, they are also frequently used to gamify applications.

Gamification is related to games in that it incorporates game design principles, but it does not result in a game. Selective inclusion of game elements precludes its ability to become a game. However, that same inclusion attempts to improve the engagement of a non-game application so that it may approach or match the engagement elicited by a game.

Gamification is related to both serious games and training simulations in that its context is serious. A gamified application's primary purpose is not entertainment; rather, entertainment is used as an engagement elicitation tool. Further similarities rely on the specific gamified

application. Indeed, a simulation itself may be the base application that is gamified. Similarly, if the application is a teaching tool, pedagogy becomes a similarity between gamification, serious games, and training simulations. However, if the application is an advertising tool, differences in primary purposes exist.

Summary of Terminology

Though related, games, serious games, training simulations, and gamification share several key differences, which necessitate the distinction in terminology. While games are created solely for entertainment, serious games and training simulations include an element of learning. Gamified applications may include a learning element, or may not. Serious games and gamified applications include an entertainment aspect, while training simulations do not. Several other key differences have been described, such as the inclusion or exclusion of gaming elements, specifically fantasy and competition, and the attempt to replicate real-life environments and conditions. These comparatives have been summarized in Figure 2.

	Game	Training Simulation	Serious Game	Gamified Applications
Designed to Entertain	**X**		**X**	**X***
Designed to Educate		**X**	**X**	
Accurate Replication of Real World		**X**		
Competition	**X**		**X**	
Goals	**X**	**X**	**X**	
Rules	**X**	**X****	**X**	
Challenge	**X**	**X**	**X**	
Choice	**X**		**X**	
Fantasy	**X**		**X**	

Figure 2. Qualities of Games, Training Simulations, Serious Games, and Gamified Applications

** Gamified applications can improve engagement though the gamification portion. Without gamification, they are not designed to entertain.*
*** Games have rules by definition. Training simulations have rules imposed by limitations (e.g., hardware, software, etc.)*

Using Game Elements to Support Motivation

Now that we have distinguished between games and their affiliates, this dissertation can proceed to discuss the significance of games to the learning realm. Research has worked to establish the ability of games and game elements to support motivation. This research will be highlighted in the proceeding discussion.

Objectives, Goals, and Rules

Objectives, goals, and rules, when properly implemented, can enhance the motivation of players (Amory, Naicker, Vincent, & Adams, 1999; Denis & Jouvelot, 2005; Jennings, 2001).

The inclusion and proper design of these elements highly impact a player's experience, and require careful consideration prior to implementation (Waraich, 2004; Zagal, Nussbaum, & Rosas, 2000; Swartout & van Lent, 2003).

The literature emphasizes a need for concurrent goals of varying levels to motivate learners (Malone, 1981; Swartout & van Lent, 2003). Three specific levels are suggested (Swartout & van Lent, 2003). First, a game should have short-term goals, which take only seconds to complete. This type of goal could be seen continuously throughout a game, satisfying a player's need for instant gratification. In the game *Super Mario Bros.* (Nintendo, 1985), players are required to make it past enemies and hazards so that they can make it to the end of the level. This goal is set every few seconds, and awards the player by giving them access to more of the level and points for completing this goal efficiently (time bonus).

Second, there should be medium-term goals. In *Super Mario Bros.*, the player is required to successfully complete levels. As the player completes their short-term goals (bypassing enemies and hazards), he or she continues to progress through the level, earning continuous small rewards (points from the enemies, coins, etc.) until the player passes all enemies and the end of the level is reached. At the end of the level, the player is given the opportunity to acquire large amounts of bonus points, and is also given access to the proceeding level, thus a larger reward.

Finally, there should be long-term goals. Following the *Super Mario Bros.* example, the long-term goal is to complete the game and save the princess. Upon completing the game, the

player is rewarded with a special cut scene, and is offered a more challenging version of the game.

Following these three goal types, players are continuously rewarded for goal completion, and are continuously motivated. While the player sometimes earns small rewards, and large rewards at other times, the reward type is consistent for each goal type. The player will always receive a small reward for completion of a short-term goal, and a large reward for completion of a long-term goal.

Further, this reward structure is consistent with reinforcement, as described by the theory of operant conditioning (Skinner, 1938). Skinner's theory explains how, through reinforcement, learning can occur. Dealing specifically with voluntary behavior, operant conditioning seeks to modify the prevalence of a behavior through the introduction of consequences. Consequences may be classified as either reinforcement, causing the learner to exhibit the behavior more frequently, or punishment, causing the learner to exhibit the behavior less frequently.

The aforementioned goal structure replicates positive reinforcement on a continuous reinforcement schedule (Ferster & Skinner, 1957). In other words, the learner is rewarded by being given something desirable every time a goal is achieved. This is in contrast to partial-reinforcement schedules, where the learner is only rewarded for some of the instances of goal achievement. This is beneficial because continuous reinforcement is effective in establishing new behavior. However, research has shown that partial-reinforcement schedules exhibit greater persistence, or resistance to extinction of the conditioned behavior, than a continuous reinforcement schedule (Nation & Woods, 1980). In light of these qualities, the long-term

benefits of a continuous reinforcement schedule are questionable. In an entertainment game like *Super Mario Bros*., it is not necessary for the player to remember information, or exhibit particular behaviors, over a long span of time. Short-term engagement is sufficient. However, when the goal includes education, long-term retention is a necessary quality. Thus the goal should be established before deciding upon an appropriate reinforcement schedule.

According to Gee's Achievement Principle, games should be designed to provide players with intrinsic rewards from the beginning (Gee, 2003). Following initial rewards, goals should be dynamic, with requirements growing along with the player's mastery. This fits nicely with the guidelines set forth by Denis and Jouvelot (2005), who state that goals should take the form of a "positive slope," allowing the learner to face ever more challenging, yet attainable, goals. With a dynamic learning curve, the player's position on the slope becomes something of a covert grade book, allowing for evaluation of the player by their progress in the game. If level two of the game presents conflicts that require a particular level of mastery to overcome, an evaluator may identify whether or not the player has attained that mastery by identifying whether or not he or she has completed the level. This has the benefit of removing external rewards (e.g., grades), which can hinder intrinsic motivation (Denis & Jouvelot, 2005).

Interactivity

Interactivity is another tool that can be used to improve motivation. In games, interactivity takes the form of gameplay. Gameplay includes the activities and strategies that were purposely implemented by game designers to motivate and engage players to complete a

game (Prensky, 2001). Gameplay can be broken up into two primary forms (Johnson, Vilhjalmsson, & Marsella, 2005). The first, moment-by-moment gameplay, refers to the actions that players execute on a frequent and regular basis, or moment-by-moment. In *Super Mario Bros*. (Nintendo, 1985), players jump on enemies every few seconds. Effective moment-by-moment gameplay does not occur by implementing high-resolution graphics, but by creating a game that asks players to continuously make decisions, which are instantly, or near instantly, met with consequences. This type of design is effective in placing players in a state of flow (Johnson, Vilhjalmsson, & Marsella, 2005). In *Super Mario Bros*., as a result of jumping on enemies, the enemies are "squished," and the player is rewarded with points and safe passage.

The second form of gameplay attempts to relate current actions to more complex goals. In *Super Mario Bros*., squishing *Goombas*, a type of enemy, leads to level completion, which eventually leads to saving the princess and game completion. This form of gameplay reduces triviality of minute actions, enabling players to identify purpose in their actions.

While interactivity is a defining quality of games, care must be taken to strike a proper balance between player autonomy and choice restriction (Swartout & van Lent, 2003). Games lacking a story and affording complete player freedom can be boring. The lack of goals and rules removes all semblance of challenge, potentially propelling players into a state of ennui. Conversely, games that exhibit too much control can remove interactivity completely. This transforms a game into a movie, giving the player no freedom of choice, or ability to influence the game through personal action. Effective balancing ensures that the player has a perception of free will, but imposes constrained options to provide adequate challenge, and an impactful

narrative to shape the player's experience, without fully defining it (Swartout & van Lent, 2003). Further, it facilitates fun, improving player attitude and promoting intrinsic motivation. In an educational setting, it aids in the maintenance of learner interest (Johnson, Vilhjalmsson, & Marsella, 2005).

Narrative

Now that the ways in which games support motivation have been highlighted, the primary topics of this dissertation can be discussed. The first of these topics is narrative. Narrative is an interesting area of study because of its pervasiveness in entertainment games, but several educational games do not include narrative, or only include a cursory implementation. If its ubiquity in entertainment games can be attributed to its effectiveness, narrative may also be effective for the purposes of learning. It may serve as a useful tool for integrating educational content with the entertaining content of games, improving motivation to fulfill the educational goals, and increasing time spent with the educational game (Mcdaniel, Fiore, & Nicholson, 2010). If these benefits exist, the frequent omission of narrative is likely to be detrimental to the goals of learning games. This dissertation seeks to examine this possibility, beginning by defining the term and then detailing the research on the effective use of narrative in games.

Definition and Structure

The literature proposes many definitions for narrative. This dissertation will adhere to one specific definition to hone its focus. Thus, this dissertation will use the definition of narrative

as an organized interpretation of a series of real or fictitious events, meant to provide meaning to those events (Genette & Levonas, 1976; Murray, 2003).

Narrative contains an initial state, events that cause a change to that state, and insight as a result of that change (Miller, 1990). In games, the initial state will correspond to the initial state of the game: the background information presented to the player, the initial setting, and plot state. Events that change that state will arise due to player interaction as the player progresses in the game. An outcome that brings about insight will result from the interaction and progression as the player changes the state of the game world, gains new powers, or acquires new knowledge about the world, other characters, or the player's character.

In games, narrative can be classified as embedded or emergent (Salen & Zimmerman, 2004). Embedded narrative is that which is prescribed by the designer. The player does not have the ability to alter embedded narrative components. They are presented in a particular way at a particular time. Most games have embedded narrative components in their main story. In *Super Mario Bros*., the protagonist is searching for a princess and goes on an adventure to find her. He travels from castle to castle, defeating the foes along the way until he finally finds her (and she is not "in another castle"), defeats her captor ("King Koopa," also known as "Bowser") and rescues her. These elements are embedded and will occur in every play through.

However, narrative can also be classified as emergent (Salen & Zimmerman, 2004). Emergent narrative refers to those narrative elements which come about in response to the way a player plays the game. Mario will travel from castle to castle and save the princess from her captor if the player plays through the entire game. However, the way in which it will happen is

up to the player and the player's ability. Perhaps Mario will run from castle to castle, vanquishing every foe with ease as he quickly and effortlessly makes it to Bowser. Bowser proves to be a worthy foe, almost defeating Mario, but Mario is victorious in the end. That is one outcome. However, it may be the case that Mario runs from castle to castle, being beaten again and again. The Goombas (enemies that the player has to squish) prove to be worthy adversaries as Mario just can't seem to successfully jump on their heads. After a long and perilous road, Mario reaches the evil Bowser. Bowser defeats Mario again and again, but Mario is tenacious and always comes back. He's determined to save the princess. Finally, Mario thinks of a new strategy and narrowly defeats Bowser, saving the princess. Thus, the narrative develops based on the way the player plays. The details of the plot take form differently if the player is skilled and defeats the content effortlessly than if the player is new to video games and struggles all the way to the end. The narrative emerges from the player's interaction with the game. While narrative consists of several other elements, this dissertation will focus specifically on plot and dialogue.

Plot can be defined as the sequence of events that compose a story (Abbott, 2007), where story may be defined as a chain of sequential incidents, states of minds, or actions (Nielsen & Madsen, 2006). Plot provides meaning to the game's events, giving the player a sense of purpose for their actions. In other words, effective implementations of plot provide a reason for the player to complete the game's content, and thus the learning content, enabling play that is meaningful.

Plot can work cohesively with dialogue. Dialogue can be defined as alternating communication based on similar topics, among two or more agents (Dignum, Dunin-Keplicz, & Verbrugge, 2000). Dialogue provides a more interesting method for unveiling plot elements than

direct narration. With dialogue, agents are developed in accordance with their "spoken" words. The constituent elements of their dialogue (word choice, sentence structure, etc.) help to define the personalities of the characters, enabling a connection to the agents that allows for increased player involvement, and possibly transportation, in the narrative. Additionally, dialogue transmits information about the plot. In a learning game, this information can also help describe the learning content and intertwine the learning content with the game elements. Thus, dialogue can be a valuable vehicle for the transmission of information from the game to the player, potentially facilitating the transfer of educational content.

Effectiveness

Plot and dialogue along with its other elements make narrative effective in many ways. Narrative is a key element in facilitating the creation of fun in serious games (Dickey, 2005; Dickey, 2006; Fisch, 2005; Waraich, 2004). Games with narrative may be more immersive than games without (Schneider, Lang, Shin, & Bradley, 2004). A well-designed narrative arc increases player engagement and serves as a source of feedback to the player (Dickey, 2006).

A well-designed narrative should be intertwined with learning content (Waraich, 2004). Adding small elements of fun to the existing learning content is ineffective. Children who are exposed to games that follow this design tend to remember the fun, forgetting the learning content (Fisch, 2005). One study (Garner, Gillingham, & White, 1989) asked children and adults to read an informative passage on insects. Half of the participants read the passage with small elements of interesting information injected into the passage. The other half read the passage without the interesting information. Those who read the passage without the interesting

information recalled an average of 93% of the most important ideas in the text. Those who read the passage with the interesting information only recalled 43% of the most important ideas. This study supports the idea that poor integration of appealing elements can serve as a distractor, instead of an enhancer. Thus, the integration of such elements should be considered carefully and integrated deliberately to support learning (Lepper & Cordova, 1992). Specifically, advancement in the narrative should be tied to advancement in learning, so that the player is required to learn, rehearse, and recall the content in order to access more of the appealing elements (Fisch, 2005; Lepper & Cordova, 1992).

Well-designed narratives promote challenge, fantasy, and curiosity (Malone, 1981; Dickey, 2006). Challenge and fantasy are part of a game by its very definition. This makes these elements easy to include, but fantasy promotes a unique challenge. While fantasy should be promoted by narrative, fantasy can be overstated. Green (2004) describes that narrative transportation is enhanced by prior experience or familiarity with plot events. In other words, fantasy should be structured in a way that is still relatable by the player. Events that are too fantastical may break the immersive effects of transportation, a result that would be detrimental to the educational potential of the game.

Care should also be taken in designing for curiosity to ensure it meets its purpose. Properly implemented curiosity-evoking mechanisms will increase engagement through the removal of predictability in the game's story or response to player action (Quinn, 1996). A well-designed game is specifically meant to recruit the player's emotions as a means of immersing

him or her in the game environment, inspiring emotional highs and lows and discouraging emotional neutrality (Malone, 1981; Swartout & van Lent, 2003).

Narrative Transportation

Related to narrative is the concept of narrative transportation. Narrative transportation can be described as complete engagement, which includes cognitive and emotional involvement in a narrative (Green & Brock, 2000; Green, Brock, & Kaufman, 2004). It is powerful enough that transported individuals using non-visual forms of media may begin to experience mental images related to the narrative (Green, 2004). While the concept of narrative transportation was not originally designed for interactive media, the ability of it to immerse participants into the narrative, mentally transporting them from "real life" to the "virtual reality," may make it particularly effective in inducing transportation into the narrative world (Green, 2004). Narrative transportation was examined more closely in this dissertation's experiment. See the Dependent Variables section for more information.

Achievements

Concluding with narrative, we can begin to look at this dissertation's second primary topic, achievements. Achievements have been gaining widespread attention over the past several years. Before proceeding, it is important to note that achievements are not defining features of

games or instructional systems. Either can exist without achievements. Instead, they are optional inclusions.

While several studies have begun to identify the inner workings of achievements, the exact ways in which they should be implemented are still being formulated. The lack of definitive methodology has not deterred companies, games, and universities, among others, from rapidly integrating achievements into their methodologies and curricula. If widespread use is to continue, it is imperative that the methodology for their effective design and implementation is understood, and that the effects of such implementation are clarified. This clarification will lead to more effective implementations and enable better decision making when making the choice of whether or not to implement achievements. This dissertation examines the role played by achievements in learning games. This section will proceed in likeness of the previous section, beginning with definitions and ending with the functions achievements can serve.

Definition and Structure

An achievement is a game-defined task-reward system, with rewards that players can unlock through the completion of in-game accomplishments (Blair, 2012; Fitzwalter, Tjondronegoro, & Wyeth, 2011; Medler, 2009). They have three primary components: signifier, completion logic, and reward (Hamari & Eranti, 2011):

Signifier – The signifier is the visual aspect of the achievement. It is the image that emerges when the achievement's name, representative image (or badge), and the objective description are combined. Figure 3 provides an example.

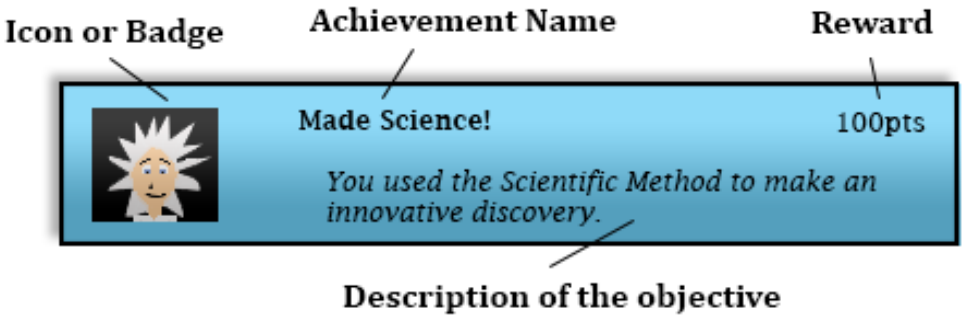


Figure 3. Components of an Achievement's Signifier

Achievements are usually related to a particular theme, whether it is similar to the game's primary theme, or something distinct. The names and images of each achievement typically adhere to that theme. However, each achievement's image and name are distinct, affording efficient recognition of each achievement. These names and images are usually related to the achievement objective.

The objective description frequently provides a clear description of the achievement's completion logic. However, this is not always the case. To increase difficulty or avoid spoilers, the description is often vaguely related to the completion logic, or completely unrelated.

The reward description simply tells the player what he or she will receive upon completing the objective. In Figure 1, the reward is 100 pts, indicative of a point value. Several other reward types exist, and will be detailed in the "Reward" section.

Completion logic – The completion logic consists of the condition(s) that must be met to unlock or earn the achievement. It is comprised of four elements: an action or event-based trigger, pre-requirements for the game setting, conditional requirements for the game state, and a multiplier.

"Trigger" is used to describe the required action from the player. It can also be used to describe the event that must occur in the game in order for the achievement to be awarded. Consider an achievement that requires the player to pass an opponent race car drivers, while inside a tunnel, and driving a car that has less than 500 horsepower. Passing an opponent driver would be the trigger. Other triggers may include "reach level 80" in a massively multiplayer online role playing game or "obtain a royal flush" in a card game.

The requirements for an achievement to be awarded are made more specific by the pre-requirements for the game setting. Continuing with the racing example, passing an opponent is an essential action, but is not enough to receive the achievement. The achievement also states a pre-requirement — "while inside a tunnel." Passing an opponent while the player is not in a tunnel will be insufficient to unlock the achievement. The player must first be in the tunnel. While this is one example of a pre-requirement, many other possibilities exist, including difficulty levels, time limits, etc.

The conditions for achievement awarding are further specified by conditional requirements for the game state. Passing a driver while in a tunnel begins to satisfice the requirements, but one condition still exists. The player must be driving a car with less than 500 horsepower – the conditional requirement for the game state. Although this is similar to the pre-requirements for the game setting, it is unique in its conditions. The game state conditional requirements may be met during the game session, while the pre-requirements must be met prior to beginning. Other game state conditional requirements could include buffs (beneficial status

effects) or debuffs (detrimental status effects) being active or inactive, being in a particular virtual location, or other conditions that may be influenced during gameplay.

Reward - Rewards describe the ramifications of unlocking an achievement. Rewards take one of three forms: internal to the game, external, or achievement as reward. Internal rewards can describe those that are found within the game world. Virtual, intangible items are frequently provided as internal rewards, typically taking the form of currency, stat boosters, or apparel, though other types exist. External, out of game rewards extend beyond the game world into the real-world environment. An external reward may include receiving a free t-shirt at an establishment you frequent for being a consistent customer. It is important to distinguish external rewards from extrinsic motivation. They are not the same. While points may be internal to a game, it is still an extrinsic reward (not an external reward). Achievements as rewards provide no direct benefit outside of earning the achievement itself. These rewards typically serve as non-functional currency, trophies, or achievement displays.

Function

Achievements serve five primary functions: facilitating goal setting, providing instruction, serving as a basis for reputation assessment, being used as status symbols/tools for self-affirmation, and a means for group identification (Antin & Chuchill, 2011).

Goal Setting

Achievements can serve as outlines for personal goal setting (Fitzwalter, Tjondronegoro, & Wyeth, 2011). Achievements provide information about milestones within a system, allowing

a player to rapidly understand what is important in the game. An achievement that reads, "Complete the game on hard difficulty, without dying" provides a goal that the user may choose to designate as personally valuable for him or herself. Since achievements can typically be viewed at any time, previewing achievements can allow a player to set goals before fully comprehending the task. This function should be paired with progress indicators, so that the user can continuously receive feedback on their progress toward the goal. This also serves a secondary role. People tend to increase effort as they approach their goal (Fox & Hoffman, 2002), providing a semi-predictable performance boost. However, it should be noted that expected achievements are not a "cure-all." While facilitating the goal setting process, expected achievements tend to decrease intrinsic motivation and perceived freedom of choice (Blair, 2012; Hecker, 2010).

Providing Instruction

Achievements can function as tutorials. The achievements signifier may provide information about what actions are possible in a game (Montola, Nummenmaa, Lucero, Boberg, & Korhonen, 2009), or it may advance further and provide information about what actions are important for success in a game. For example, an achievement that reads "Kill 10 players, without dying, in Deathmatch mode," hints to the player that Deathmatch is about defeating other players, and that doing well requires that the player survive. Achievements may also function as instructional feedback (McDaniel, Lindgren, & Friskics, 2012). The completion of simpler achievements can serve as indicators of progress in the achievement of a larger goal.

Reputation

Achievements may be useful in providing information about a player's reputation. The type of information provided by a player's completion or non-completion of an achievement can be useful when inferring a player's interests or past interactions. Depending on the nature of the achievement, it may also provide information about a player's skill-set or expertise. If a player has completed an achievement that reads, "Achieve the highest rank in competitive gameplay," it is reasonable to assume that the player has attained a high level of mastery. In combination, these qualities may be useful in inferring a player's trustworthiness, or history within the specific gaming community.

Status Symbol / Self-Affirmation

Achievements are frequently seen as status symbols. Achievements give information about a player's accomplishments. Since achievements are game-specific, and players are playing the same game, it may then follow that the gamers share an interest in the activities that the achievement represents. If this assumption is not violated, achievements may then serve as status symbols, as players may look more favorably on a player who has completed the achievement's objectives. Status is a highly valued trait among gamers (Plass & Homer, 2009). Achievements also serve as a means of self-affirmation, as the achievement functions as an everlasting reminder of the completion of the objectives that are represented by the achievement.

Group Identification

Finally, achievements may help individuals identify with groups. Achievements represent completed objectives, but they may further represent experiences that a player has undergone in the midst of objective completion. Players who have completed the same achievement may then be able to identify with others who have undergone similar experiences, facilitating the formation of a social bond that is sparked by or revolves around those experiences. Research has also revealed a potential for positive effects on the establishment of common ground and reciprocity in social gaming (Wohn, Lee, Sung, & Bjornrud, 2010).

Purpose of Study

The purpose of this study is to begin exploring the ways in which the specific game features of achievements and narrative interact with a serious game. While several studies examine the effects of game features on non-game applications, the literature does not tend to examine the effectiveness of common game features when implemented in the context of a serious game. This study considered two such features: achievements and narrative. It aimed to answer several questions. Do these features improve, detract from, or have no discernable effect on learning when added to a serious game? What, if any, effects do they have on metrics traditionally related to enjoyment (e.g., flow, engagement, etc.)?

CHAPTER THREE: HYPOTHESES AND EXPERIMENTAL METHODOLOGY

Chapter three aims to precisely define the questions that were asked in this study and detail the methodology used in examining these questions. Here, the sample that participated will be described, followed by an examination of the testbed, variables, and procedures that were implemented.

Hypotheses

Learning Outcomes

H1: Across all participants, post-test scores will be significantly higher than pre-test scores

H2: Participants in the achievements, narrative, and combined conditions will learn more information, as measured by pre/posttest performance than participants in the control condition

Perceived Engagement

H3: Participants in the combined and narrative conditions will have higher levels of perceived engagement than participants in the achievement or control conditions

H4: Participants in the combined and achievements condition will have higher levels of perceived engagement than participants in the control condition

Perceived Intrinsic Motivation

H5: Participants in the narrative condition will have higher levels of perceived intrinsic motivation than participants in the achievement, control, or combined conditions

H6: Participants in the combined and achievements conditions will have higher levels of perceived intrinsic motivation than participants in the control condition

Perceived Narrative Transportation

H7: Participants in the combined and narrative conditions will have higher levels of perceived narrative transportation than participants in the achievement or control conditions

H8: Participants in the control condition will have higher levels of perceived Narrative Transportation than participants in the achievement condition

Perceived Flow

H9: Participants in the narrative condition will have higher levels of perceived flow than participants in the achievement, control, or combined conditions

H10: Participants in the achievements and combined conditions will have higher levels of perceived flow than participants in the control condition

Game-based Classification Accuracy

H11: Participants in the narrative and combined conditions will have higher accuracy than players in the achievement or control conditions.

Participants

80 participants (40 female, 32 male) between the ages of 18 and 38 (Mean = 18.8, SD = 2.9) were recruited through a leading participant management system. All participants were undergraduate students from the psychology department at the University of Central Florida.

Participants were screened for recent drug use, including alcohol, tobacco, caffeine, sedatives, anti-psychotics, and anti-depressants. All participants had normal or corrected to normal vision in order to ensure consistency in visual acuity and dissuade performance differences due to inferiority of vision. The restrictions checklist used can be found in Appendix A.

Participants were divided into four groups: Achievements, Narrative, Combined, and Control. The control group did not encounter achievements or narrative in experimentation. The Achievements and Narrative groups encountered the Achievements feature, or the Narrative feature, respectively. The combined group experienced both achievements and narrative.

Experiment Equipment

Participants played through an entire serious game, *Medulla*, on a standard desktop computer. Participants interacted with the interface through the use of a mouse and keyboard. All participants viewed the game on equally large-sized flat screen monitors at a resolution of 1920x1080 pixels.

Experimental Testbed: *Medulla*

Medulla (Figure 4) places the player in the role of a young boy who is tasked with saving the world. The evil King Myelin is wreaking havoc on the city of Medulla, casting mental illnesses on the Medullan citizens. The player must defeat King Myelin and his minions while curing the Medullans' illnesses. Medulla had two primary mechanics: 1) Shooting brainwaves, and 2) Curing illnesses.

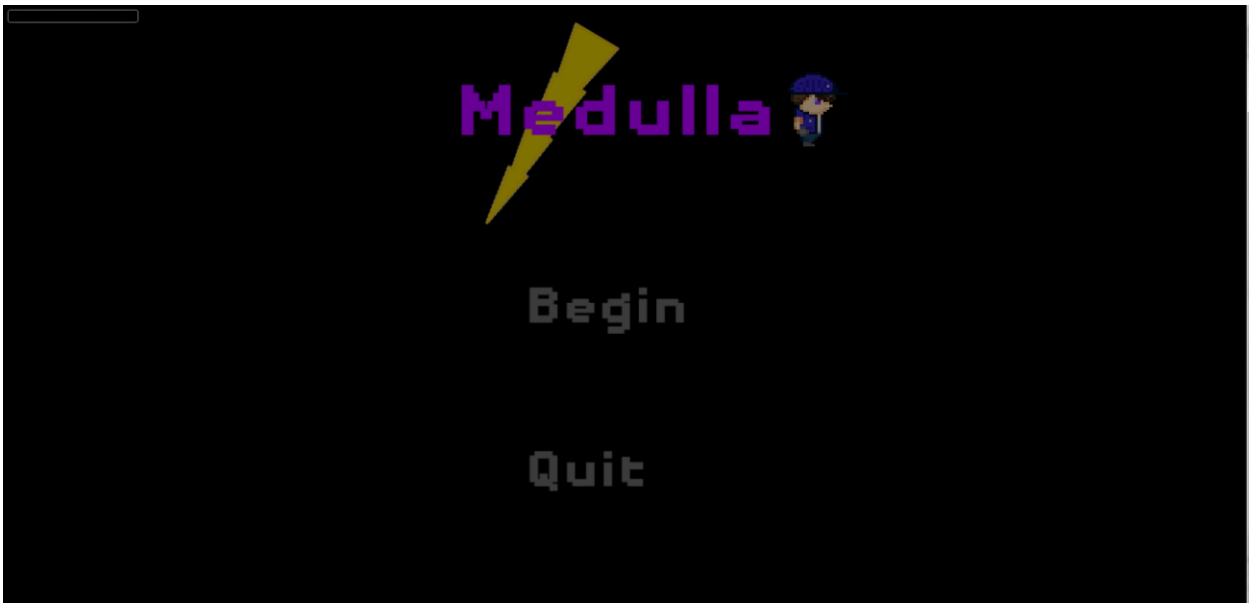


Figure 4. Medulla Title Screen

Brainwaves functioned as the attacking mechanism, taking the form of basic projectiles that instantiate from the avatar's head and travel forward for a few milliseconds before being destroyed (Figure 5). If the projectile collides with an enemy, the enemy is defeated and despawns. Brainwaves were launched by right clicking the mouse.

Figure 5. Shooting Brainwaves to Defeat Enemies

Players encountered ill Medullans that required curing. Upon approaching an ill Medullan, the player could no longer move. Depending on the condition, the Medullan either presented fantasy-based dialog (e.g., “I can’t see. Everything has gone dark. Is anyone there?”) or the game presented non-narrative instructions (e.g., “Click the part of the brain that is associated with vision”) The text was related to the portion of the brain that was afflicted (e.g., Occipital Lobe). An image of the brain appeared, enabling the ability to decide which part of the brain was afflicted and click it (Figure 6). Correctly choosing awarded the player with extra health and points. Failure to choose correctly resulted in a second try. Incorrectly choosing on the second try decreased the player’s health and did not award points. After the player chose correctly, or chose incorrectly twice, the player’s controls were returned so that he or she could proceed through the level.

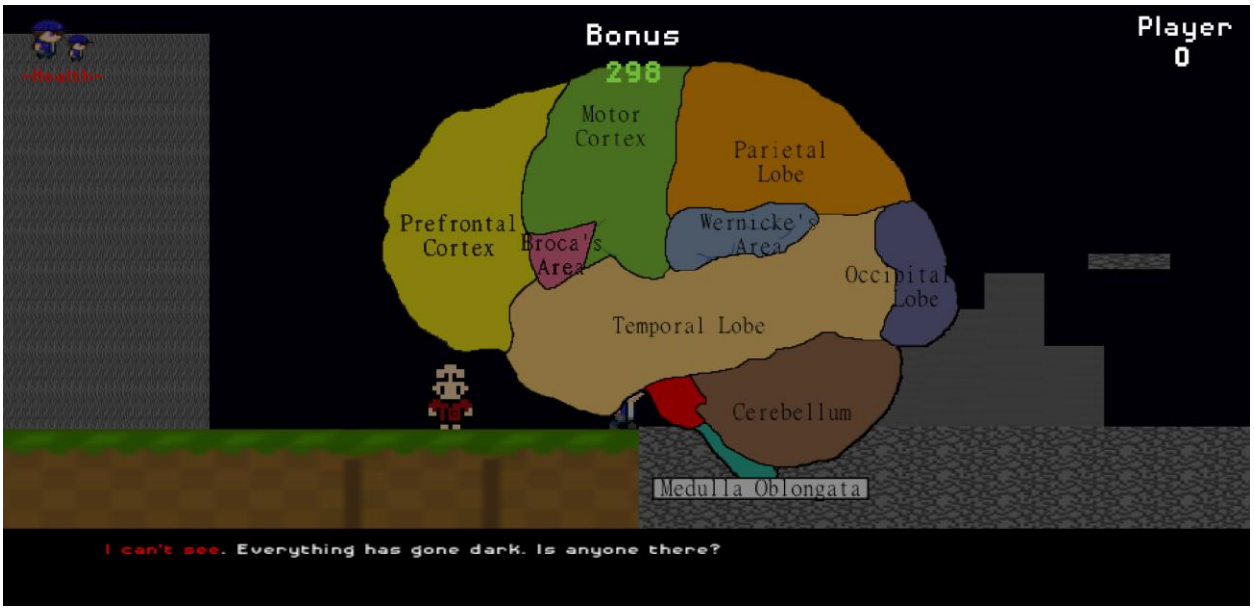


Figure 6. Clicking the Brain to Cure Ill Citizens

While the game that *Medulla* was based on was originally designed as part of an Instructional Game Design Course with Julie Salcedo, Javier Rivera, and Corina Lechin, no game was ever developed. *Medulla* underwent major design changes and was then developed by the author using Unity3D. It took the form of a two-dimensional platformer. The final aesthetic is pixel-based, reminiscent of the retro genre and the games that inspired the genre.

The gameplay feels most similar to a fusion between *Super Mario Bros*. and *Mega Man*. There is a substantial amount of platforming-based gameplay, where the user is required to make precise jumps in order to progress through the level or collect points. However, the shooting element often required players to slow their pace in order to prevent themselves from running into an enemy that first needed to be defeated. In this manner, enemies were used as tools to

regulate the player's speed and progression as the author attempted to integrate a mix of fast-paced gameplay with slower, more deliberate, thought-based play (Figure 7).

Figure 7. Using Enemies to Control Pace of Gameplay

However, the ability of non-player agents to control pacing brought about its own challenge. The citizens that needed to be cured placed players at an abrupt stop, forcing gameplay into the narrow constraints of question and answer. The proper balance needed to be found between this interruption of gameplay, which enabled practice of the learning content, and smoother, more continuous gameplay. While this was not a critical issue in the first level, where plays only knew one brain area, it became very critical by the end of the game, where the players needed to recall and practice with 9 parts of the brains. The solution was found in front- and backloading the learning content within each level. Evenly spacing ill citizens within a level

would have resulted in interruptions every few seconds. By placing most of the ill citizens at the beginning and end of each level, with a few interspersed in between, the learning content became less of an intrusion on enjoyment (as determined from informal preliminary playtesting). In response, more ill citizens could be placed, allowing for more time to be spent practicing the learning content, while reducing the perception of intrusiveness.

The final version of *Medulla* included between 34 and 76 minutes of gameplay (mean = 50.96). *Medulla* was carefully designed (over 500 hours went into the development of the game), but still included some bugs. For example, sometimes upon death, the player's avatar would completely disappear. Restarting the level would result in an avatar that could not move from the start position. Another major bug resulted in the player being able to move certain walls and platforms that should have been immovable. This made it impossible for the player to continue the level. Participants who encountered these bugs were not included in the final dataset.

Independent Variables

Achievements

In the Achievements condition, participants will receive achievements as they complete various game goals. Achievements were created in accordance with the best practices outlined in the literature. In accordance with those practices, the requirements of each achievement were not shown to the participant until the achievement is earned. All achievements were skill-based, requiring the player to demonstrate some level of skill or competency before receiving them.

This condition will be compared to the control condition, which will be identical except for the absence of achievements. See Appendices K, L, and M for screenshots of achievements.

Narrative

In the Narrative condition, participants were exposed to a progressive adventure-based plot, where the term "progressive" is used to describe a series of events that lead to a positive net gain for the protagonist, as judged from the change in the protagonist's position from the beginning to the end of the plot (Kemp, 2010). Participants were also exposed to thematic dialogue between the main character and other virtual agents, as well as dialogue between multiple non-playable virtual agents. The dialogue was primarily focused on the task at hand, strongly linked to the plot, but also included elements of humor. See Appendix J for a complete screenplay.

The participant's avatar and primary protagonist will be part of a world, Medulla, which is being overtaken by the evil SIR THOR THE DESTROYER (also known as Terry Milton, but he doesn't like that name). THOR is wreaking havoc, casting mental illnesses on the Medullan citizens. He has also unleashed his minions which serve as weaker, but more numerous, tools of destruction. The player's task is to defeat THOR and his minions, while curing the Medullans of their illnesses. In the narrative condition, dialogue occurred between NPCs and the player, exposing the participant to this story. This condition was compared to the control condition, which was identical except for the absence of the story. In the control condition, dialogue only occurred when necessary to communicate required knowledge (i.e., the function of each brain

area, e.g., “The Occipital Lobe controls vision.”) and prompt the user for answers (e.g., “Which part of the brain controls vision?”). The story revolving around Medulla and THOR was not expressed.

Dependent Variables

Performance Measures

Pre/Post Test Performance

The Pre/Posttest measured the participants’ knowledge of the brain structure and function information taught in the game. The pretest and posttest were identical to allow for comparison. Every question was weighted equally. This test included two parts. The first part assessed knowledge of the primary functions of each major brain region. The second part assessed knowledge of the location of each major brain region. The pre/posttest questionnaires are located in Appendix H.

Game-Based Classification Accuracy

Game-Based Classification Accuracy measured the participants’ performance within the game as it pertained to the knowledge of brain structure and function. It was assessed every time the participant was required to click on a brain region to “cure” a citizen.

In-Game Score

In-Game Score measured the participants’ total game performance as it pertained to the knowledge of brain structure and function and to the game elements. The score was increased for

defeating enemies and curing citizens. A time bonus was awarded for the amount of time left at the end of each level.

Total Game Time

Total Game Time measured the total time, in minutes, that the participant spent playing the game. The time began at the start of the first level and ended at the completion of the boss fight at the end of the game session.

Questionnaires

This section describes the questionnaires that were used in this study. Qualtrics was used to disseminate all questionnaires.

Restrictions Questionnaire

The Restrictions Questionnaire assessed the participant's eligibility for the study, ensuring that the participant had not taken any performance-altering drugs, did not have vision impairments, and was between the ages of 18-40.

Demographics Questionnaire

The Demographics Questionnaire assessed the participant's age, gender, race, education level, previous technology experience (e.g., experience with computers and video games), and gaming experience. The full demographics questionnaire can be found in Appendix B.

Game Features Questionnaire

The Game Features Questionnaire is a set of nine subjective questions developed by the author of this dissertation. This questionnaire was used to evaluate the positive and negative impacts of the game's features on the participant's experience while playing the game. The Game Features Questionnaire can be found in Appendix E

Engagement Measure

The Engagement Measure is a combination of two questionnaires (Jennett, et al., 2008; Charlton & Danforth, 2005), and is a subjective measure used to evaluate engagement in a task. It consists of 15 items related to perceived effort, interest, and enjoyment in a recent task. The Engagement Measure can be found in Appendix I.

Flow State Short Scale (FSSS)

The Flow State Short Scale (Jackson, Martin, & Eklund, 2008) is a nine-item subjective measure that measures flow from nine dimensions: Challenge-skill balance; action-awareness merging; clear goals; unambiguous feedback; concentration on the task at hand; sense of control; loss of self-consciousness; time transformation; and autotelic experience. The FSSS can be found in Appendix C.

Intrinsic Motivation Inventory (IMI)

The Intrinsic Motivation Inventory (SelfDeterminationTheory.org, n.d.; Ryan, 1982) is a subjective measure used to assess participants' interest/enjoyment, perceived competence, effort, and feelings of value/usefulness as they relate to an activity or task. The IMI can be found in Appendix F.

Narrative Transportation Scale

The Narrative Transportation Scale (Green & Brock, The role of transportation in the persuasiveness of public narratives, 2000) is a 12-item subjective scale used to measure narrative transportation. While it is meant to apply to a variety of mediums, some modification was required to make it applicable to a game environment. The questionnaire requires participants to circle a number along a seven-item scale to indicate the degree to which they were transported into the narrative in various ways, ranging from "not at all" to "very much." Five questions were omitted due to their inapplicability to a visual, interactive environment (e.g., "While I was reading the narrative, I could easily picture the events in it taking place"). Thus a seven-item scale was provided to the participant. The Narrative Transportation Scale can be found in Appendix G.

Procedure

Upon arrival, participants were asked to sit in front of the experimental computer and were required to silence their mobile phones in order to reduce the potential for distraction.

Participants first completed the restrictions checklist, ensuring the participant met the minimum required criteria to be included in the dataset. Next, participants were provided with an Institutional Review Board approved informed consent document, providing a brief overview of the experiment, explaining the purpose, general procedure, and anticipated risks, along with the participant's rights.

Following the consent process, participants completed a demographics questionnaire, followed by an 18-question pre-test to assess prior knowledge. No feedback was provided on correctness.

Participants then played the game in its entirety. After the game ended, participants completed a post-test, identical to the pre-test. Finally, participants completed the IMI, Engagement Measure, Narrative Transportation Scale, and the Flow State Short Scale. This concluded the experiment.

CHAPTER FOUR: EXPERIMENT ANALYSIS

One-way analysis of variance was used for hypothesis testing. ANOVA indicated that participants in each condition did not differ in prior knowledge ($F(3, 76) = .573$, $p = .634$), total game time ($F(3, 76) = .557$, $p = .645$), or in-game score ($F(3, 76) = 1.878$, $p = .140$). Table 1 provides values for descriptive statistics.

Table 1. Descriptive Statistics for Pretest, Total Score, and Total Game Time

Dependent Variable by Condition	Minimum	Maximum	Mean	Std. Deviation
Pretest (Control)	4	18	8.50	4.03
Achievements	2	14	8.65	3.94
Narrative	2	18	7.15	4.31
Combined	2	16	7.70	4.33
Total Score (Control)	142222	190219	171664.25	11538.27
Achievements	142548	199441	171162.85	14936.06
Narrative	133439	184367	168155.35	11878.75
Combined	157536	199799	177204.95	10428.30
Total Game Time (Minutes) (Control)	40	71	52.25	9.17
Achievements	34	72	51.45	11.09
Narrative	34	76	51.65	10.05
Combined	35	70	48.50	9.77

Achievement earning behavior was recorded for participants in both achievement and non-achievement conditions, where those in achievement conditions actually received the achievement and those in non-achievement conditions received no indication of meeting the requirements for an achievement (i.e., were not awarded the achievement). Several achievements were earned by every participant, while one, Pacifist (completing a level without killing any

enemies) was never earned by any participants. Table 2 provides the breakdown for the number of each achievement earned by condition. No significant differences were found between conditions for any of the remaining achievements. These included: Curing an optional citizen, $\chi^2(3, N = 80) = 6.32$, $p = 0.10$, completing a level without dying, $\chi^2(3, N = 80) = 2.66$, $p = 0.45$, killing self while a minion of THOR, $\chi^2(3, N = 80) = 2.35$, $p = 0.50$, attacking a friendly NPC, $\chi^2(3, N = 80) = 1.43$, $p = 0.70$, and finishing a level with more time than the player began with, $\chi^2(3, N = 80) = .56$, $p = 0.10$.

Table 2. Number of Each Achievement Earned by Condition

Achievements by Condition	N	Sum
Savior of Motor Cortex (Completed level 1) - Control	20	20
Achievements	20	20
Narrative	20	20
Combined	20	20
Savior of Occipital (Completed level 2) – Control	20	20
Achievements	20	20
Narrative	20	20
Combined	20	20
Savior of Medulla City (Completed level 3) – Control	20	20
Achievements	20	20
Narrative	20	20
Combined	20	20
Savior of Parietal (Completed level 4) – Control	20	20
Achievements	20	20
Narrative	20	20
Combined	20	20
Savior of Temporal (Completed level 5) - Control	20	20
Achievements	20	20
Narrative	20	20
Combined	20	20

Achievements by Condition	N	Sum
Savior of Motor Cortex (Completed level 1) - Control	20	20
Achievements	20	20
Narrative	20	20
Combined	20	20
Savior of Prefrontal Cortex (Completed level 6) – Control	20	20
Achievements	20	20
Narrative	20	20
Combined	20	20
Savior of Cerebellum (Completed level 7) - Control	20	20
Achievements	20	20
Narrative	20	20
Combined	20	20
Savior of …? (Completed level 8) – Control	20	20
Achievements	20	20
Narrative	20	20
Combined	20	20
Savior of a Planet (Completed game) – Control	20	20
Achievements	20	20
Narrative	20	20
Combined	20	20
Helpful (Cured 1 citizen) – Control	20	20
Achievements	20	20
Narrative	20	20
Combined	20	20
Kind (Cured 3 citizens in a row) – Control	20	20
Achievements	20	20
Narrative	20	20
Combined	20	20
Benevolent (Cured 10 citizens in a row) – Control	20	20
Achievements	20	20
Narrative	20	20
Combined	20	20
Caring (Cured all citizens in a level) – Control	20	20

Achievements by Condition	N	Sum
Savior of Motor Cortex (Completed level 1) - Control	20	20
Achievements	20	20
Narrative	20	20
Combined	20	20
Achievements	20	20
Narrative	20	20
Combined	20	20
Heroic (Cured an optional citizen) – Control	20	20
Achievements	20	19
Narrative	20	20
Combined	20	17
Lucky Shot (Killed one enemy) – Control	20	20
Achievements	20	20
Narrative	20	20
Combined	20	20
Warrior (Killed ten enemies) – Control	20	20
Achievements	20	20
Narrative	20	20
Combined	20	20
Feared (Kill fifty enemies) – Control	20	20
Achievements	20	20
Narrative	20	20
Combined	20	20
Pacifist (Completed a level without killing enemies) – Control	20	0
Achievements	20	0
Narrative	20	0
Combined	20	0
Invincible (Completed a level without dying) – Control	20	11
Achievements	20	8
Narrative	20	6
Combined	20	9
Dedicated (Killed self while a minion of THOR) – Control	20	2
Achievements	20	5

Achievements by Condition	N	Sum
Savior of Motor Cortex (Completed level 1) - Control	20	20
Achievements	20	20
Narrative	20	20
Combined	20	20
Narrative	20	2
Combined	20	3
Violent (Attacked a friendly NPC) – Control	20	7
Achievements	20	6
Narrative	20	7
Combined	20	4
Time Traveler (Finished with more time than started with) – Control	20	9
Achievements	20	10
Narrative	20	8
Combined	20	8
Moon Walker (Pressed both arrow keys at once) - Control	20	20
Achievements	20	20
Narrative	20	20
Combined	20	20

Hypotheses 1 and 2: Pretest Posttest

Hypothesis 1 predicted that post-test scores would be significantly higher than pre-test scores. A paired samples t-test revealed significantly higher post-test scores than pre-test scores ($M_{pre\text{-}test} = 8.00$, $SD_{pre\text{-}test} = 4.122$; $M_{post\text{-}test} = 17.39$, $SD_{post\text{-}test} = 1.782$; $t(79) = -21.643$, $p < .001$, $d = 2.420$). See Table 3 and Table 4. These results indicate that the game significantly increased test scores on a magnitude of almost two and a half standard deviations. Hypothesis 1 is upheld and the null hypothesis is rejected.

Table 3. Descriptive Statistics for Posttest and Difference Scores

Dependent Variable by Condition	Minimum	Maximum	Mean	Std. Deviation
Posttest (Control)	13	18	17.40	1.27
Achievements	16	18	17.85	.489
Narrative	7	18	17.00	2.73
Combined	11	18	17.30	1.87
Posttest – Pretest (Control)	0	14	8.90	3.74
Achievements	4	16	9.20	3.82
Narrative	7	18	17.00	2.73
Combined	2	14	9.60	3.98

Table 4. Paired Samples t-test for Hypothesis 1

					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	Pretest - Posttest	-9.388	3.879	.434	-10.251	-8.524	-21.643	79	.000

Hypothesis 2 predicted that participants in the achievements, narrative, and combined conditions would learn more information, as measured by pre/posttest performance than participants in the control condition. ANOVA was performed to see if the deltas between pre- and post-tests differed between conditions. The results indicated no significant difference between any conditions ($F(3, 76) = .229$, $p = .876$). See Table 5. Thus, hypothesis two is not upheld and the null hypothesis is not rejected.

Table 5. ANOVA for Hypothesis 2

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	10.637	3	3.546	.229	.876
Within Groups	1178.350	76	15.505		
Total	1188.988	79			

Hypotheses 3 and 4: Perceived Engagement

Hypothesis 3 predicted that participants in the combined and narrative conditions would have higher levels of perceived engagement than participants in the achievement or control conditions. Hypothesis 4 predicted that participants in the combined and achievements condition would have higher levels of perceived engagement than participants in the control condition. ANOVA revealed no significant difference in perceived engagement between any of the tested conditions ($F(3, 76) = .107$, $p = .956$). See Table 6 and

Table 7. The null hypotheses are retained, and hypotheses 3 and 4 are not upheld.

Table 6. Descriptive Statistics for Perceived Engagement

Condition	Minimum	Maximum	Mean	Std. Deviation
Control	30	59	43.30	7.53
Achievements	23	54	42.35	7.53
Narrative	28	55	42.80	6.08
Combined	24	56	42.10	7.68

Table 7. ANOVA for Hypotheses 3 and 4

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	16.737	3	5.579	.107	.956
Within Groups	3977.750	76	52.339		
Total	3994.487	79			

Hypotheses 5 and 6: Perceived Intrinsic Motivation

Hypothesis 5 predicted that participants in the narrative condition would have higher levels of perceived intrinsic motivation than participants in the achievement, control, or combined conditions. Hypothesis 6 predicted that participants in the combined and achievements conditions would have higher levels of perceived intrinsic motivation than participants in the control condition. ANOVA revealed no significant difference in perceived intrinsic motivation between any of the tested conditions ($F(3, 76) = .713$, $p = .547$). See Table 8 and Table 9. The null hypotheses are retained, and hypotheses 5 and 6 are not upheld.

Table 8. Descriptive Statistics for Perceived Intrinsic Motivation

Condition	Minimum	Maximum	Mean	Std. Deviation
Control	74	125	102.15	14.31
Achievements	73	136	105.20	7.53
Narrative	72	148	107.50	18.90
Combined	86	134	109.50	14.72

Table 9. ANOVA for Hypotheses 5 and 6

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	576.250	3	192.083	.713	.547
Within Groups	20467.700	76	269.312		
Total	21043.950	79			

Hypotheses 7 and 8: Perceived Narrative Transportation

Hypothesis 7 predicted that participants in the combined and narrative conditions would have higher levels of perceived narrative transportation than participants in the achievement or control conditions. Hypothesis 8 predicted that participants in the control condition would have higher levels of perceived Narrative Transportation than participants in the achievement condition. ANOVA revealed no significant difference in perceived narrative transportation between any of the tested conditions ($F(3, 76) = .708$, $p = .550$). See Table 10 and Table 11. The null hypotheses are retained, and hypotheses 7 and 8 are not upheld.

Table 10. Descriptive Statistics for Perceived Narrative Transportation

Condition	Minimum	Maximum	Mean	Std. Deviation
Control	16	41	26.60	6.56
Achievements	18	39	28.00	5.09
Narrative	17	37	26.50	5.67
Combined	15	39	28.70	5.52

Table 11. ANOVA for Hypotheses 7 and 8

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	69.800	3	23.267	.708	.550
Within Groups	2498.000	76	32.868		
Total	2567.800	79			

Hypotheses 9 and 10: Perceived Flow

Hypothesis 9 predicted that participants in the narrative condition would have higher levels of perceived flow than participants in the achievement, control, or combined conditions. Hypothesis 10 predicted that participants in the achievements and combined conditions would have higher levels of perceived flow than participants in the control condition. Shapiro-Wilk Test of Normality revealed that the data for the combined condition was non-normal ($p = 0.03$). A negative skew was found, upon further inspection. Data points were squared to achieve normality. Shapiro-Wilk revealed that the data had achieved normality ($p = .50$).

ANOVA on the normalized data revealed no significant difference in perceived flow between any of the tested conditions ($F(3, 76) = 1.426$, $p = .242$). See Table 12, Table 13, and Table 14. The null hypotheses are retained, and hypotheses 9 and 10 are not upheld.

Table 12. Descriptive Statistics for Perceived Flow (Before Transformation)

Condition	Minimum	Maximum	Mean	Std. Deviation
Control	27	45	36.40	4.64
Achievements	18	42	33.75	5.85
Narrative	29	42	35.95	3.69
Combined	27	42	34.30	4.24

Table 13. Descriptive Statistic for Perceived Flow (After Transformation)

Condition	Minimum	Maximum	Mean	Std. Deviation
Control	729	2025	1345.40	336.16
Achievements	324	1764	1171.55	365.97
Narrative	841	1764	1305.35	264.46
Combined	729	1764	1193.60	289.75

Table 14. ANOVA for Hypotheses 9 and 10

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	428738.850	3	142912.950	1.426	.242
Within Groups	7615783.100	76	100207.672		
Total	8044521.950	79			

Hypothesis 11: Game-based Classification Accuracy

Hypothesis 11 predicted that participants in the narrative and combined conditions would have higher accuracy than players in the achievement or control conditions. ANOVA revealed a significant difference in game-based classification accuracy between conditions ($F(3, 76) = 3.806$, $p = .013$). See Table 15 and Table 16.

Table 15. Descriptive Statistics for Game-Based Classification Accuracy

Condition	Minimum	Maximum	Mean	Std. Deviation
Control	.92	1.00	.99	.02
Achievements	.95	1.00	.99	.01
Narrative	.83	1.00	.96	.04
Combined	.84	1.00	.97	.04

Table 16. ANOVA for Hypothesis 11

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.010	3	.003	3.806	.013
Within Groups	.070	76	.001		
Total	.080	79			

Tukey's post-hoc indicated that participants assigned to the narrative condition differed significantly from participants in the control condition ($p = .046$, $d = .939$), as well as participants in the achievements condition ($p = .017$, $d = .986$). Classification accuracy was significantly lower for the narrative condition in both instances ($M_{Control} = .99$, $SD_{Control} = .019$; $M_{Achievements} = .99$, $SD_{Achievements} = .013$; $M_{Narrative} = .96$, $SD_{Narrative} = .041$; $M_{Combined} = .97$, $SD_{Combined} = .032$). Hypothesis 11 is unsupported and the null hypothesis is rejected.

CHAPTER FIVE: EXPERIMENT DISCUSSION

This study examined the teaching effectiveness of a two-dimensional platformer game as well as the effects of achievements and narrative on a variety of performance and engagement-related factors. Hypotheses 1 and 2 examined learning in terms of pre- and post-test scores. All participants significantly improved from pre-test to post-test, but the improvement did not occur in response to the inclusion or exclusion of achievements or narrative. There was no significant difference in response to their presence or absence. While the game did teach the subject matter, with a large effect size, achievements and narrative cannot be supported as impactful moderators of learning in this study.

Hypotheses 3 through 10 examined the potential for changes in perceived engagement, perceived intrinsic motivation, perceived narrative transportation, and perceived flow as a result of the inclusion of achievements or narrative. No significant differences were found. The ability for achievements and narrative to alter these states is unsupported by this study.

Finally, hypothesis 11 examined differences in game-based classification accuracy as a function of achievements and narrative. Participants in the narrative condition had significantly lower classification accuracy than participants in the control and achievements conditions, with no significant differences observed between the combined condition and any other condition.

Overall, the results are fairly clear. The game was highly effective in teaching the content, but neither narrative nor achievements were influential on the effectiveness of Medulla's ability to teach, or to promote any of the variables tested.

This raises the question, *Why*? Narrative seemed to be a likely candidate for increasing engagement, and is very closely related to narrative transportation. Participant gameplay behaviors may have been at least partially to blame. Participants in this study were given course credit, by their instructors, for completing studies. There were no guidelines for study performance. As such, many participants appeared to be hurrying through the game. Since participants could move through the dialogue at their own pace (by pressing the spacebar to advance), a substantial portion of the participants in the narrative and combined conditions were observed pressing the spacebar repeatedly until the dialogue was finished, effectively skipping the narrative and forcing the condition to more closely resemble the achievements condition, except for one thing. In doing this, they also skipped the portions of the narrative that explained the parts of the brain and their functions for each level, reducing the overall efficacy of the game as a learning device. Such skipping behavior was not seen in the non-narrative conditions. This also explains the reduced game-based classification accuracy. Due to the gameplay mechanics that punished the player for failing to cure citizens (mechanics that slowed gameplay), participants may have made an effort to quickly learn how to cure each type of citizen during the feedback provided after an incorrect answer. In this way, the feedback acted as a safeguard to learning, still enabling the learning content to be transmitted. This is reflected in the similar post-test scores between all conditions.

In this light, it is easy to begin considering narrative as a non-essential, and possibly intrusive, game feature. This is a plausible conclusion, especially when players are rewarded for speed. However, an equally plausible possibility is that narrative requires particular design

considerations in order to be effective. For instance, many role-playing games, a genre known for the depth and creativity of their narratives, implement dialogue through the appearance of words being typed on screen. The speed of typing is indicative of the speed in which the NPC would be speaking. The dialogue cannot be skipped until the typing is complete. This sort of strategy should be empirically tested against the present method — showing the entire line of type on the screen, at once, and allowing the player to advance as quickly as desired. The results of such experimentation would provide valuable information regarding the effectiveness of narrative implementation.

It is also possible that the narrative was not written effectively, or in an interesting manner. The author of the game's narrative did not have a background that favored creative writing. Future experimentation, shedding light on the importance of expertise in narrative construction, would highlight the essentiality of experienced writers for narratives in serious games.

Beyond narrative, achievements also lacked influence in this experiment, a result that is consistent with previous findings (Hakulinen, Auvinen, & Korhonen, 2013). These findings also echo Blair (2012) who found that expected and unexpected achievements were not responsible for increases in post-test performance, intrinsic motivation, or enjoyment; achievements were only significant in a condition that combined expected incremental achievements with post-play notification of achievement award. Blair suggests that these features were more powerful in unison than in isolation. It is perhaps the case that, in this study, the specific instantiation of achievements, alone, was not powerful enough to produce significant differences.

For additional consideration, achievements were faced with an issue similar to narrative in this study. While achievement award was made conspicuous, via a purple tab that appeared in the lower right hand corner of the screen, it only included a message that said "Achievement Unlocked" and the name of the achievement. During fast-paced gameplay, this may not have been substantial enough to warrant more than the player's minimal attention. While it may not be effective practice to interrupt the player's gameplay with achievements, another remedy may exist. Loading screens are common in many games. One potential solution would be to include a "dummy" loading screen in between levels. Players could be given access to their achievements for the duration of the loading screen, allowing them to browse their achievements while they wait for the next level to load. A similar approach could involve displaying the achievements that were earned in a particular level for a few seconds at the completion of each level. In *Medulla*, players were notified once as an achievement was unlocked. Beyond that, a player was required to pause the game (and gameplay) in order to view achievements. They were not shown at any other time.

Overall, it seems a tighter embedding within the game's framework may be a more effective way to implement achievements and narrative. Future game designers should avoid treating these as "add-on" features, and consider how they may be weaved into the fabric of the game itself. Features that are not explicitly integral to the game and learning may be overlooked, especially in educational games that may not yet be engaging enough to sustain prolonged attention. Designers should continuously engage in perspective-taking, asking themselves *if I was the player, what would I be gaining from this feature?* If the answer is "nothing" or "nothing

unless I complete this sequence of unnecessary steps," redesign may be in order. To this end, just as educational content and game content should be seamlessly intertwined from the beginning of the design process (as demonstrated by Medulla), so should game content, narrative, and achievements.

Future research should examine this design process to identify its merit. In addition to the aforementioned recommended narrative and achievement implementation methods, future research should also examine these elements in reference to individual player differences. It may be the case that narrative in games is unappealing to some gamer populations, a thought that may be echoed by some gamers' preference for narrative-heavy role playing games, while others despise the genre. Individual personality differences may also be responsible for the motivation to actively engage with these game elements. Individuals who take more active roles in their learning may require less guidance by the game's design, while those who are more passive may lack the drive to seek out seemingly extraneous features.

Additionally, narrative in educational games is an area that is characterized by its lack of research. While this study did not discover the best way to implement narrative, it revealed several new questions. Future studies should examine the value of including expert writers in the design process to see if well-formed narrative is essential for effectiveness. Relatedly, type of narrative is also an interesting area of study. While Medulla primarily included text-based narrative, a greater portion of visual narrative may be more engaging. Seemingly unnecessary reading may be a barrier for players who would otherwise willingly engage with the narrative. Animations, colors, and other visual effects may be more suitable for a game environment. Even

after studying visual narrative, it may then be more useful to specifically examine intrusive visual narrative (e.g., cutscenes that interrupt play) in contrast to non-intrusive visual narrative (e.g., animations that occur in the field of view while the player still has control of his or her character). Also, highly deliberate use of sound to convey affect may also be a less intrusive, and more effective, method of providing the player with information.

CHAPTER SIX: CONCLUSIONS

This dissertation has examined the effects of the integration of achievements and narrative into a two-dimensional platformer learning game. Neither achievements nor narrative promoted improvement in any of the variables tested. Potential limitations were discussed, including the tendency of participants to not view the achievements screen and to skip the dialogue. The author suggests making these elements more robust to player influence. Future studies should examine these modifications in relation to the implementation methodologies used in this game. These studies will provide valuable insight into the effectiveness of these two features.

Despite the insubstantiality of achievements and narrative in their present form, *Medulla* was highly effective in promoting learning regarding basic brain structure and function. Additionally, although no formal measures were collected that would allow for empirical evaluation, the game seemed to be well received by participants. Many stated that they enjoyed the game; some specifically stated that they enjoyed it more than other educational games they had played. Complementarily, several audible and visual signs of immersion were present, including affirmative shouting, flinching upon death, and gasping in surprise, among others. In response, the gameplay and various design aspects described within this dissertation should be considered in the future design of educational games. Establishing commonality between the design elements in *Medulla* and those in other serious games may shed light on improved educational game design methodologies. However, the author cautions that it is imperative to move beyond the establishment of commonality and into empirical investigation.

The development of educational games is a complex process that will require an extensive amount of examination. As the field continues to advance, educational game designers, researchers, and entertainment game designers must remember to cooperate. This will be the most efficient route in navigating the complexity proposed by all forms of game design, so that the most effective games may be developed for their corresponding purposes.

APPENDIX A: RESTRICTIONS CHECKLIST

Restrictions Checklist

	Yes	No
Are you 18-40 years old?		
Do you have normal or corrected to normal vision?		
Do you have full color vision?		
Have you had any nicotine in the last 2 hours?		
Have you had any alcohol in the last 24 hours?		
Have you had any sedatives or tranquilizers in the last 24 hours?		
Have you had any caffeine in the last 2 hours?		
Have you had any anti-psychotics or anti-depressants in the last 24 hours?		

APPENDIX B: DEMOGRAPHICS QUESTIONNAIRE

Participant # _____ Age _____ Major _____ Date _____ Gender ___

1. What is the highest level of education you have had?
Less than 4 yrs of college ____ Completed 4 yrs of college ____ Other ____

3. How many hours per day do you use a computer? _____

4. For each of the following questions, circle the response that best describes you.

How often do you:
Play Facebook games or other social games (Farmville, Candy Crush, etc.)?
Daily, Weekly, Monthly, Once every few months, Rarely, Never

Use a keyboard and mouse to play computer games that are NOT social games (NOT Farmville, Candy Crush, etc.)?
Daily, Weekly, Monthly, Once every few months, Rarely, Never

Use a keyboard and mouse to play first person shooter games on a computer (Counterstrike, Medal of Honor, Team Fortress 2, etc.)?

Play handheld games, smartphone games, or console-based games that use a controller?
Daily, Weekly, Monthly, Once every few months, Rarely, Never

Read books for entertainment?
Daily, Weekly, Monthly, Once every few months, Rarely, Never

Watch movies for entertainment?
Daily, Weekly, Monthly, Once every few months, Rarely, Never

5. Which type(s) of computer/video games do you most often play if you play at least once every few months?

6. Are you in your usual state of health physically? YES NO
If NO, please briefly explain:

7. How many hours of sleep did you get last night? _____ hours

11. How much experience do you have with video games?

0	1	2	3	4	5
Not at all			Average		High

12. What is your occupation? _____

APPENDIX C: FLOW STATE SHORT SCALE

Flow State Short Scale

Instructions: Please respond to the following statements in relation to your experience with this activity. Each statement relates to the thoughts and feelings you may have experienced. Think about how you felt during the scenario and respond by circling the number for how much you agree or disagree with each statement.

During the scenario:	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
1. I felt I was competent enough to meet the high demands of the situation.	1	2	3	4	5
2. I did things spontaneously and automatically without having to think.	1	2	3	4	5
3. I had a strong sense of what I wanted to do.	1	2	3	4	5
4. I had a good idea about how well I was doing, while I was performing the task.	1	2	3	4	5
5. I was completely focused on the task at hand.	1	2	3	4	5
6. I had a feeling of total control over what I was doing.	1	2	3	4	5
7. I was not worried about what others may have been thinking about me or my performance.	1	2	3	4	5
8. The way time passed seemed to be different from normal.	1	2	3	4	5
9. The experience was extremely rewarding.	1	2	3	4	5

APPENDIX D: IMMERSIVE TENDENCIES QUESTIONNAIRE

Immersive Tendencies Questionnaire

Instructions: Read each question thoroughly and circle one number to indicate the degree of your response, unless otherwise noted by any specific question instructions.

1. Do you ever get extremely involved in projects that are assigned to you by your boss or your instructor, to the point of exclusion of other tasks?

1	2	3	4	5	6	7
Never involved						Involved

2. How easily can you switch your attention from the task in which you are currently involved to a new task?

1	2	3	4	5	6	7
Cannot switch						Can easily switch

3. How frequently do you get emotionally involved (angry, sad, happy, etc.) in the news stories that you read or hear?

1	2	3	4	5	6	7
Infrequently						Frequently

4. How well do you feel today?

1	2	3	4	5	6	7
Not well						Very well

5. Do you easily become engrossed, or deeply involved, in movies or TV dramas?

1	2	3	4	5	6	7
Not easily involved						Very easily involved

6. Do you ever become so involved in a television program or book that people have problems getting your attention?

1	2	3	4	5	6	7
I am never that involved						I am frequently that involved

7. How mentally alert do you feel at the present time?

1	2	3	4	5	6	7
Not mentally alert						Very mentally alert

8. Do you ever become so involved in a movie that you are not aware of things happening around you?

1	2	3	4	5	6	7
I am never						I am

that involved						frequently that involved

9. How frequently do you find yourself closely identifying with the characters in a story line?

1	2	3	4	5	6	7
Infrequently						Frequently

10. Do you ever become so involved in a video game that it is as if you are inside the game rather than moving a joystick and watching the screen?

1	2	3	4	5	6	7
I am never that involved						I am frequently that involved

11. How physically fit do you feel today?

1	2	3	4	5	6	7
Not fit						Very fit

12. How good are you at blocking out external distractions when you are involved in a task?

1	2	3	4	5	6	7
Not very good						Very good

13. When watching sports, do you ever become so involved in the game that you react as if you were one of the players?

1	2	3	4	5	6	7
I am never that involved						I am frequently involved

14. Do you ever become so involved in a daydream that you are not aware of things happening around you?

1	2	3	4	5	6	7
I am never that involved						I am frequently involved

15. Do you ever have dreams that are so real that you feel disoriented when you wake up?

1	2	3	4	5	6	7
Infrequently						Frequently

16. When playing sports, do you become so involved in the game that you lose track of time?

1	2	3	4	5	6	7
I am never						I am

that involved frequently involved

17. Are you easily disturbed when working on a task?

1	2	3	4	5	6	7
Never disturbed						Easily disturbed

18. How well do you concentrate on enjoyable activities?

1	2	3	4	5	6	7
Concentrate poorly						Concentrate well

19. How often do you play arcade or video games? (OFTEN should be taken to mean every day or every two days, on average.)

1	2	3	4	5	6	7
Not often						Very often

20. How well do you concentrate on disagreeable tasks?

1	2	3	4	5	6	7
Concentrate poorly						Concentrate well

21. Do you get excited during chase or fight scenes on TV or in the movies?

1	2	3	4	5	6	7
Not often						Very often

22. To what extent have you dwelled on personal problems in the last 48 hours?

1	2	3	4	5	6	7
Not often						Very often

23. Have you ever gotten scared by something happening on a TV show or in a movie?

1	2	3	4	5	6	7
Not often						Very often

24. Have you ever remained apprehensive or fearful long after watching a scary movie?

1	2	3	4	5	6	7
Not often						Very often

25. Do you ever avoid carnival or fairground rides because they are too scary?

1	2	3	4	5	6	7
Not often						Very often

26. How frequently do you watch TV soap operas or docu-dramas?

1	2	3	4	5	6	7
Not often						Very often

27. Do you ever become so involved in doing something that you lose all track of time?

1	2	3	4	5	6	7
Not often						Very often

APPENDIX E: GAME FEATURES QUESTIONNAIRE

To what extent did the following features impact your overall experience

while playing the game (circle one number for each):

1. Sounds / Music:

Large negative impact	1	2	3 No impact	5	6	Large positive impact

2. Storyline:

Large negative impact	1	2	3 No impact	5	6	Large positive impact

3. Characters:

Large negative impact	1	2	3 No impact	5	6	Large positive impact

4. Visuals / Graphics:

Large negative impact	1	2	3 No impact	5	6	Large positive impact

5. Achievements:

Large negative impact	1	2	3 No impact	5	6	Large positive impact

6. How well the controls translated to your avatar's movement:

Large negative impact	1	2	3 No impact	5	6	Large positive impact

7. Curing citizens with brain powers:

Large negative impact	1	2	3 No impact	5	6	Large positive impact

8. Design of the levels:

Large negative impact	1	2	3 No impact	5	6	Large positive impact

9. Using brainwaves to defeat enemies (pressing ctrl):

Large negative impact	1	2	3 No impact	5	6	Large positive impact

APPENDIX F: INTRINSIC MOTIVATION INVENTORY

Intrinsic Motivation Inventory

Instructions: For each of the statements below, please indicate how true it is for you, using the following rating scale:

1	2	3	4	5	6	7
Not at all true			Somewhat true			Very true

1. I enjoyed doing this activity very much. _____
2. I think I am pretty good at this activity. _____
3. I put a lot of effort into this. _____
4. This activity was fun to do. _____
5. I did not feel nervous at all while doing this. _____
6. I didn't try very hard to do well at this activity. _____
7. I think I did pretty well at this activity, compared to other students. _____
8. I felt very tense while doing this activity. _____
9. After working at this activity for a while, I felt pretty competent. _____
10. I thought this was a boring activity. _____
11. I was very relaxed while doing this task. _____
12. This activity did not hold my attention at all. _____
13. I tried very hard on this activity. _____
14. I would describe this activity as very interesting. _____
15. I am satisfied with my performance at this task. _____
16. I was anxious while working on this task. _____
17. I thought this activity was quite enjoyable. _____
18. It was important to me to do well at this task. _____
19. I was pretty skilled at this activity. _____
20. This was an activity that I couldn't do very well. _____
21. I didn't put much energy into this. _____
22. I felt pressured while doing this task. _____

While I was doing this activity, I was thinking about how much I enjoyed it. _____

APPENDIX G: NARRATIVE TRANSPORTATION SCALE

Narrative Transportation Scale

Instructions: Read each question and circle the number to indicate the degree of your response.

1. While I was reading the narrative, activity going on in the room around me was on my mind .

1	2	3	4	5	6	7
Not at all			Neutral			Very much

2. I was mentally involved in the narrative while reading it.

1	2	3	4	5	6	7
Not at all responsive			Neutral			Very responsive

3. After the narrative ended, I found it easy to put it out of my mind.

1	2	3	4	5	6	7
Not at all natural			Neutral			Very natural

4. I wanted to learn how the narrative ended.

1	2	3	4	5	6	7
Not at all			Neutral			Very much

5. The narrative affected me emotionally.

1	2	3	4	5	6	7
Not at all natural			Neutral			Very natural

6. I found myself thinking of ways the narrative could have turned out differently.

1	2	3	4	5	6	7
Not at all compelling			Neutral			Very compelling

7. I found my mind wandering while reading the narrative.

1	2	3	4	5	6	7
Not at all			Neutral			Very much

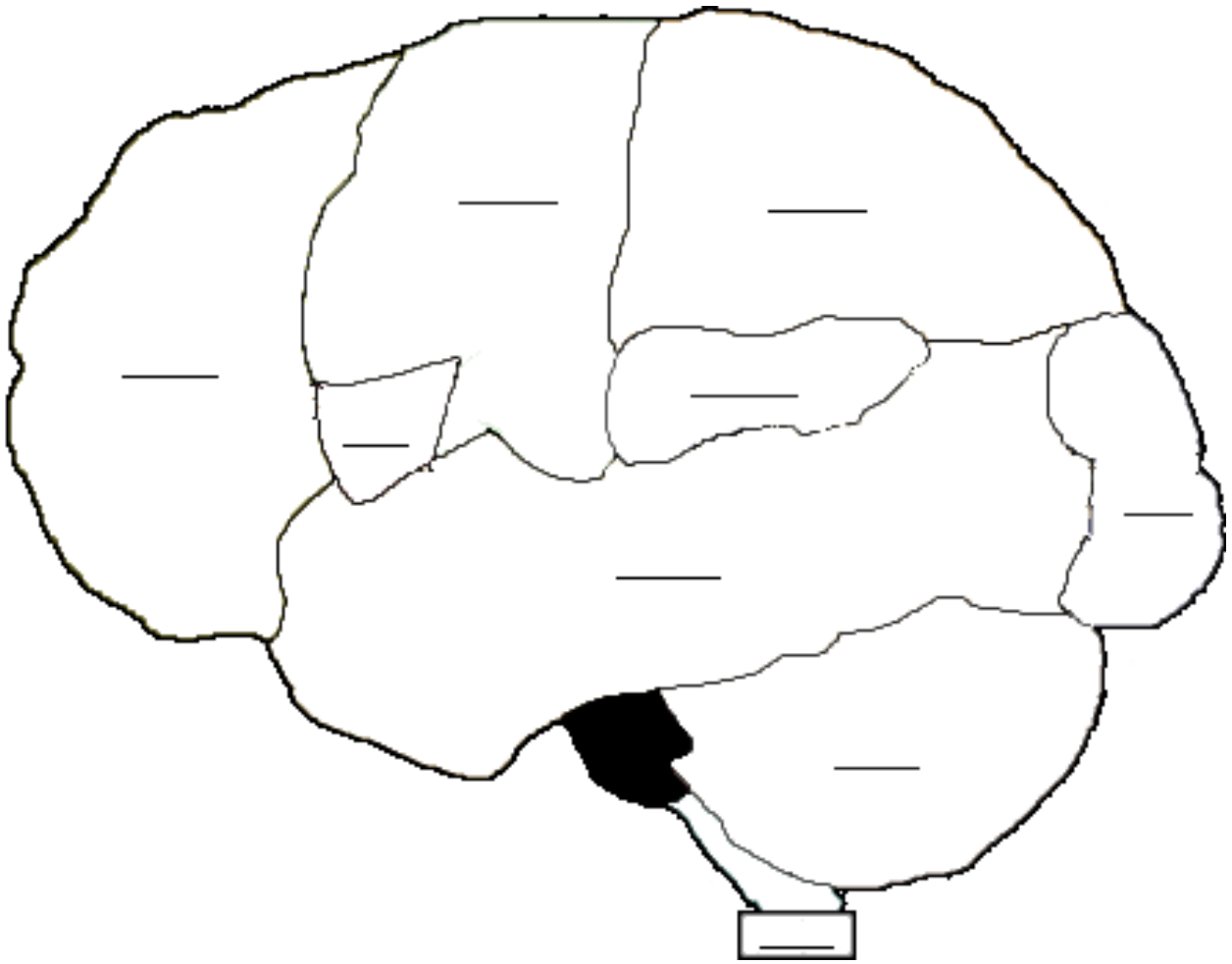
APPENDIX H: PRE/POSTTEST QUESTIONNAIRE

Match each brain region to the corresponding function, by marking the letter of the function on the line next to the region.

Broca's Area ___	A. Decision making/moderating social behavior
Cerebellum ___	B. Voluntary muscle movement
Medulla ___	C. Speech
Motor Cortex ___	D. Speech
Occipital Lobe ___	E. Vision
Parietal Lobe ___	F. Regulation and coordination of posture and balance
Prefrontal Cortex ___	G. Processes touch, pressure and pain
Temporal Lobe ___	H. Maintains breathing and heartrate
Wernicke's Area ___	I. Hearing / Auditory Perception

Match each brain region to the corresponding location, by marking the letter of the region inside of each location. Use each letter only once.

A. Broca's Area	B. Cerebellum	C. Medulla
D. Motor Cortex	E. Occipital Lobe	F. Parietal Lobe
G. Prefrontal Cortex	H. Temporal Lobe	I. Wernicke's Area



APPENDIX I: ENGAGEMENT MEASURE

KEY

Enter the number circled for each item.

Note: Items #1 and #3 are reverse scored.

Instructions: For each statement, circle the number that indicates how much you agree or disagree with the statement.

1. It would not matter to me if I never played a game like this again. This item is reverse scored.

1=5	2=4	3=3	4=2	5=1
Strongly disagree	Disagree	Neutral	Agree	Strongly Agree

2. I felt happy at the thought of playing this game.

1	2	3	4	5
Strongly disagree	Disagree	Neutral	Agree	Strongly Agree

3. The less I have to do with this game, the better. This item is reverse scored.

1=5	2=4	3=3	4=2	5=1
Strongly disagree	Disagree	Neutral	Agree	Strongly Agree

4. I would like to spend more time playing games like this one.

1	2	3	4	5
Strongly disagree	Disagree	Neutral	Agree	Strongly Agree

5. It was important to me to perform well in this game.

1	2	3	4	5
Strongly disagree	Disagree	Neutral	Agree	Strongly Agree

6. I experienced a “buzz of excitement” while playing this game.

1	2	3	4	5
Strongly disagree	Disagree	Neutral	Agree	Strongly Agree

7. I like the challenge that this game provided.

1	2	3	4	5
Strongly disagree	Disagree	Neutral	Agree	Strongly Agree

8. I was interested in seeing how this game would progress.

1	2	3	4	5
Strongly disagree	Disagree	Neutral	Agree	Strongly Agree

9. I was in suspense about whether I would perform well or not in this game.

1	2	3	4	5
Strongly disagree	Disagree	Neutral	Agree	Strongly Agree

10. I enjoyed completing the game's objectives.

1	2	3	4	5
Strongly disagree	Disagree	Neutral	Agree	Strongly Agree

11. I feel that I tried my best in this game.

1	2	3	4	5
Strongly disagree	Disagree	Neutral	Agree	Strongly Agree

12. This game was challenging.

1	2	3	4	5
Strongly disagree	Disagree	Neutral	Agree	Strongly Agree

13. Achievements motivated me to do well in this game.

1	2	3	4	5
Strongly disagree	Disagree	Neutral	Agree	Strongly Agree

14. The story and characters motivated me to do well in this game.

1	2	3	4	5
Strongly disagree	Disagree	Neutral	Agree	Strongly Agree

APPENDIX J: NARRATIVE SCREENPLAY

Level One

OUTSIDE – EVENING – EERIE WIND AUDIO PLAYING

PLAYER is standing to the left of PURPLE SHIRT CITIZEN

PURPLE SHIRT CITIZEN

-Hey! Are you affected!?
-Glad to know I'm not alone. I've been in hiding. I have the power, but I didn't want to come out on my own.
-Are you from around here, I mean, a citizen of Motor Cortex?
-Perfect! So then, you have the motor cortex power too! You can help!
-We need to use it to cure the citizens and get to the town of Occipital to ask for help.
-Now that we can watch each other's backs, this should be easy. I'm so relieved that..

Lightning bolt strikes PURPLE SHIRT CITIZEN.
PURPLE SHIRT CITIZEN begins moving away from PLAYER.

PURPLE SHIRT CITIZEN

-Wait, no, I can't stop myself! Please do something!

PURPLE SHIRT CITIZEN moves further.

PURPLE SHIRT CITIZEN

-Oh no, I can feel it starting again.
Hurry!

PURPLE SHIRT CITIZEN moves further and off the screen.

PURPLE SHIRT CITIZEN

-SAVE ME!

PURPLE SHIRT CITIZEN is gone and PLAYER is allowed to move freely. PLAYER progresses through the level until reaching the end. RED SHIRT CITIZEN stands to the right of PLAYER with happy expression.

RED SHIRT CITIZEN

-Thank you! But our princess is in another cas… No, that’s not right.
-You must be the one everybody’s talking about. The savior of motor cortex!
-Don’t forget about that motor cortex power you have. Several citizens were seen escaping to occipital. I’m sure there will be more citizens having trouble controlling their body there.
-Anyway, get moving. You’ve seen movies. You saved one town, so now you have to save the world.
-Yes, the world. The evil Terry Milton... Whoops. I forgot. He doesn't like to be called that anymore.
-Ahem.. the evil 'SIR THOR THE DESTROYER(TM)' was sighted heading toward the town of Occipital, and who knows where he’ll go next.
-...Seriously? You don't know who he is? He's the guy who is making everyone sick! You're not a very educated hero... but you'll have to do, I suppose.
-Don't just stand there! GET GOING!

Level ends. Level Two begins.

Level Two

OUTSIDE – EVENING – MUSIC PLAYING
PLAYER is standing to the left of RED SHIRT CITIZEN

RED SHIRT CITIZEN

- Could it be? Are you…? I mean, you look a little shrimpy, but I think you just might be..
- T-Dogg from Motor Cortex said you'd be on your way. Thanks be to the gods!
-This is Occipital... well, not quite. You'll be there in a moment.
- See, THOR THE DESTROYER covered it with earth, so now it's underground – quite dark too.
-Take the Occipital power, the power of our city. Most of my people are trapped underground, riddled with illness and unable to find their way out.
- The Occipital power will cure anybody with this illness, allowing them to see once more!
- I'd go in myself, but I'm afraid of the dark, and I don't really like people anyway…
- But you! You look like you're a caring person. Please save them! I mean, if you want. Otherwise, we could sit here and talk for a while. I am sort of bored with the bowling alley being underground. Hard to hit those turkeys when you can't see a da...
- ...Oh, you're going to go help? Great… That's what I really wanted you to do… Umm. Good choice. Yay.
- You'd better get going then. Use your Occipital power to cure the vision of my people!

PLAYER is allowed to move freely. PLAYER progresses through the level until reaching the end. RED SHIRT CITIZEN stands to the right of PLAYER.

RED SHIRT CITIZEN

- I SEE that you've done well. Har har har!"
- Thanks for saving everyone, but it's time you move on.

- Quick! Go to Medulla City! They need your help, but beware. I hear it's a creepy place.
- Don't forget about your Occipital power for vision and Motor Cortex power for body control!

Level ends. Level Three begins.

Level Three

OUTSIDE – EVENING – MUSIC PLAYING
PLAYER is standing to the left of RED SHIRT CITIZEN

RED SHIRT CITIZEN

- H… h… hi…
-…please… take my family – not me!
-Oh… you're going to… help us?
-You're not a ghost.. are you?
-..oh…well that's pleasant. This is Medulla City, where we take good care of your heartbeat.
-Mine is pounding…
-You might find this Medulla power useful…
-Alright then… you go on ahead now… but beware… nobody can save you once you've entered…
-It's been nice knowing you…

PLAYER is allowed to move freely. PLAYER progresses through the level until reaching the end. RED SHIRT CITIZEN stands to the right of PLAYER.

RED SHIRT CITIZEN

-They're all gone? Medulla is safe? ..perhaps my heart can return to normal..
-I think I'll just take it slow…

-I guess you should go help Parietal now… or you could say "screw that" and be our personal 24 hour guardian. I'd really be ok with that.
- No? You'd prefer to go and die a gruesome death? Alright, but don't forget about your Medulla power and its ability to fix heartbeats.

Level ends. Level Four begins.

Level Four

OUTSIDE – EVENING – MUSIC PLAYING
PLAYER is standing to the left of RED SHIRT CITIZEN

RED SHIRT CITIZEN

-I'M THE SERGEANT! WELCOME TO PARIETAL, THIN MINT!
-ARE YOU READY TO FEEL THE PAIN!?
-WE AINT NEITHER BUT THOR DON'T CARE!
-NOW THERE IS PAIN EVERYWHERE!!!
-STOP BEING A DAMNED SISSY PANTS AND GET YOUR PUNY BEHIND IN THE ARENA!
-SHUT YOUR WHINY FACE! TAKE THIS POWER AND CURE THE PAIN OF PARIETAL
-I THINK I'LL KEEP IT BECAUSE I LIKE THE WAY IT TINGLES! WOOOOOOOOOO YEAH! FEEL THE BURN, BABY!

PLAYER is allowed to move freely. PLAYER progresses through the level until reaching the end. RED SHIRT CITIZEN stands to the right of PLAYER.

RED SHIRT CITIZEN

-HI THERE SCRAWNY TOES!
-WHY AM I STILL YELLING NOW THAT THE PAIN IS GONE!?
-BECAUSE I LIKE YELLING!

-YOU KNOW WHAT ELSE!? I LIKE YOU TOO, MILK MUFFIN! GOOD WORK!!!
-NOW GET ON, BUT DON'T FORGET TO CURE PAIN WITH YOUR PARIETAL POWER!

Level ends. Level Five begins.

Level Five

OUTSIDE – DAY – MUSIC PLAYING
PLAYER is standing to the left of BEARDED RED SHIRT CITIZEN

BEARDED RED SHIRT CITIZEN

-Hello, young stranger. Will you face our danger?
-Ahh good – I've had no fears, for we are the famous sky beards!
-Temporal is our hoe and here is our power. Our hearing has gone for more than an hour.
- Now try not to look down, but cure everyone. The sun is at high, and there's work to be done.
- One more thing - upon curing our weirds, you'll restore the grace of our magnificent beards.

PLAYER is allowed to move freely. PLAYER progresses through the level until reaching the end. BEARDED RED SHIRT CITIZEN stands to the right of PLAYER.

BEARDED RED SHIRT CITIZEN

- Good day, young friend. You have saved our city. Did you call me sir? NOW THAT IS...
-witty.
-Is it my beard that confuses you? I have not a clue.
-I am a woman, though I'm less trimmed than you.

-Never mind all of that, it’s time for you to go. It seems you’re becoming quite the hero.
-Never forget Temporal is hearing.
-It’s a phrase and a thought that is always worth bearing.

Level ends. Level Six begins.

Level Six

OUTSIDE – EVENING – MUSIC PLAYING
PLAYER is standing to the left of RED SHIRT CITIZEN

RED SHIRT CITIZEN

- Hissss. Heeeello. Weeelcome to the Prefrontal Cortex LabORatory, THOR’s primary research facility. Hissssss
-I am Igor, an enslaaaved researcher. I would never commit such heinous crimes. I prefer little bunny rabbits and sugary treats, but I only eat one of them!
-… most of the time…
-Take this prefrontal cortex pooower. It will cure inappropriate social behaaavior and bad decision making. Hissssssss”
- Good luck to you. You’re becoming quite well known. Perhaps you are worthy of being called the saaavior. Hisss…

PLAYER is allowed to move freely. PLAYER progresses through the level until reaching the end. RED SHIRT CITIZEN stands to the right of PLAYER.

RED SHIRT CITIZEN

- Thaaank you, my friend. Destroying this research facility is a maaajor step toward saving the planet of Medulla.

- Onward now. Do not forgeeet the Prefrontal Cortex power and its ability to promote social behavior and decision making.
- Also, do not forgeeet to bring me tiny little bunny rabbit with soft soft fur.
-Hisss…

Level ends. Level Seven begins.

Level Seven

OUTSIDE – EVENING – MUSIC PLAYING
PLAYER is standing to the left of RED SHIRT CITIZEN

RED SHIRT CITIZEN

-Hi friend! Welcome to Cerebellum!
-We're a little wobbly these days, but this was once the happiest place on Medulla!
- Of course, our spirits aren't down too much, but we do need some help!
- I don't think there's a person who doesn't know your name and the things you've accomplished.
- You're getting close to THOR THE DESTROYER's territory. Just push a little further.
- Before you go, take the Cerebellum power and help anybody who is having trouble with their balance.
-Thanks friend!

PLAYER is allowed to move freely. PLAYER progresses through the level until reaching the end. RED SHIRT CITIZEN stands to the right of PLAYER.

RED SHIRT CITIZEN

- You're so amazing, and may I say you look both beautiful and handsome this fine afternoon!

- I don’t know what we’d do without you... can I make you tea or something?
- Oh you’re right. I wouldn’t want to keep you. Our neighbors really need you.
-Don't forget to use the Cerebellum power to cure balance illnesses. Stop back in any time!

Level ends. Level Eight begins.

Level Eight

OUTSIDE – EVENING – MUSIC PLAYING
PLAYER is standing to the left of BROCA & WERNICKE

BROCA & WERNICKE

-Hi there! (Hello!)
-We’re the twins who run this place! Broca (and Wernicke!)
-Yes, as you can see, we’re a bit inseparable! Heh heh, I know you love that one, Broca! (That joke gets ‘em every time, Wernicke!)
- Oh yes, on to business. (You need to save our town!)
- Here are two powers, one named Broca and one named Wernicke (I wonder where they got those incredible names!)
- You say all of the other powers are named after the city? You want to know the name of our city? (Why should he care?)
- None of that matters, young one! All that matters are the fantastic siblings Broca… (and Wernicke!)
- Now get on. You’ll need to use both of the powers to cure speech issues. If you hear somebody spouting garbledygook, you should use both powers in sequence (it doesn’t matter which order!)
- Thanks pal, and never forget the incredible powers of Broca and Wernicke!

PLAYER is allowed to move freely. PLAYER progresses through the level until reaching the end. BROCA & WERNICKE stand to the right of PLAYER.

BROCA & WERNICKE

-Woohoo! (We did it!)
-Broca and Wernicke saved the day again!
-Oh, you say you did it? (Well, I never..)
- I don't know how you would've cured all of those speech ailments without the dauntless duo of Broca and Wernicke powers!
- You don't want credit anyway? (Now, that's a true hero!)
- We thank you for your help! Now go forward to THOR THE DESTROYER's territory! (Good luck uni-head!)

Level ends. Boss Fight Level begins.

Boss Fight

OUTSIDE – EVENING – EERIE WIND AUDIO PLAYING
PLAYER is allowed to move freely. PLAYER progresses through the level until reaching PURPLE SHIRT CITIZEN and four RED SHIRT CITIZENS. PURPLE SHIRT CITIZEN stands on top of a platform suspended above RED SHIRT CITIZENS.

PURPLE SHIRT CITIZEN

-Oh. Hi there buddy! Remember me from Motor Cortex? I escaped. Come closer. I need your help.
-Oh nevermind. Who am I kidding? I can zap you from this distance! MWAHAHA!
-Oh, you thought I was captured by THOR?

PURPLE SHIRT CITIZEN becomes THOR. THOR smiles deviously, exposing fangs.

THOR

-I AM THOR! Now come here so you can lose your life beside your friends.

RED SHIRT CITIZENS smile and each raise one hand into the air.

RED SHIRT CITIZENS

-You don’t have to fight him alone! We’ll help. Just cure us if we get zapped.

RED SHIRT CITIZENS return to neutral pose and expression.

THOR

- Let it begin!

RED SHIRT CITIZENS TURN AROUND AND BEGIN ATTACKING THOR. PLAYER is free to move and fights THOR’s minions while curing RED SHIRT CITIZENS.

RED SHIRT CITIZENS attack THOR while cured. When an illness is cast, THOR wears devious smile and raises arm into the air while a lightning bolt strikes RED SHIRT CITIZEN. RED SHIRT CITIZENS stop attacking THOR and turn around to face camera. When PLAYER cures RED SHIRT CITIZEN, RED SHIRT CITIZEN turns back around and resumes attacking.

When THOR’s health is low, the platform below him begins to smoke. When THOR’s health nears zero, the platform catches fire. Play continues until THOR’s health reaches zero.

THOR

- What is this!?

THOR wears an expression of fear.

THOR

- This isn’t possible!

THOR's platform is destroyed. THOR falls toward the ground, rotating in a circle, yelling "NOOOOOOOOOOOOOO!" until he collides with the ground. THOR lands on his head. The scene fades to black. Boss Fight Level ends. Endgame cinematic begins.

End Game Cinematic

A bright white light fades into the screen, followed by a fade to black. Only text is visible. No audio is playing.

TEXT

- It is clear in my mind, to this day.
-It was the first day of my life. Obviously I speak in metaphor. Nobody remembers the first day of their life, but it feels like the truth.
-It was five years ago.
-I woke up with a stabbing pain at the top of my head.

Red quickly fades in and out to represent the pain. Bass drum plays in sync with flashing red.

TEXT

–There was no recollection of why it had hurt.

Red stops. Screen is suddenly black.

TEXT

-There was no recollection of anything.
-Who was I? I wore the body of an adult, yet I couldn't remember a moment of its evolution.
-They told me my name was Terry Milton. I can't say I liked it, but what was I to do?
-I moved on. I decided I would do whtever I could to recollect my memories.
-The drive has faded with time. I found a passion – a love for something greater than my former identity – my life's work.
-I found a dream.

-I am Dr. Terry, Head Veterinarian of Motor Cortex.

Scene fades in. INSIDE at TERRY'S VETERINARIAN. THOR becomes DR. TERRY. Music begins playing. DR. TERRY stands between a dog (left) and ill cat, laying on its side with X'ed eyes (right), with birds perched overhead. DR. TERRY walks toward the cat and heals it. The cat raises to its feet with a smile.

DR. TERRY

-I was brought here by a friend. It's his home town.
-He helped me to establish myself. I could never repay him.
-Now it is time for me to continue my journey. Farewell. Stay in touch.

Scene fades to black. After a moment, text appears.

DR. TERRY

-And let me know if you ever need my services. My rates are very affordable.

Text fades to black. Menu screen is loaded. Game has ended.

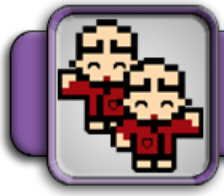
APPENDIX K: LIST OF ACHIEVEMENTS


I
Savior of Motor Cortex - Completed Level One.
The Journey Begins.
II
Savior of Occipital - Completed Level Two.
III
Savior of Medulla City - Completed Level Three.
IV
Savior of Parietal - Completed Level Four.
V
Savior of Temporal - Completed Level Five.
VI
Savior of Prefrontal Cortex - Completed Level Six. Have you been killing citizens this whole time..?
VII
Savior of Cerebellum - Completed Level Seven.

Savior of...? - Completed Level Eight. *No idea what the city was called, but what an interesting pair...*

Savior of a Planet - Completed the game. *Congratulations. Your work is no longer necessary. Now, join the unemployment line.*

Helpful - Cured one citizen in need. *This is only the beginning.*



Kind - Cured 3 citizens in a row. *Please... help the others.*

Benevolent - Cured 10 citizens in a row. *You are truly making the world a better place.*

Caring - Cured all citizens in a level. *Your heart is open. Your skills are unmatched.*

Lucky Shot - Defeated one of Myelin's minions. *Wow. I did it. ...but can I do it again?*

Warrior - Defeated ten of Myelin's minions.
I can defeat them, but I must remain cautious.

Feared - Defeated fifty of Myelin's minions.
Approach! Your demise will be swift and merciful.

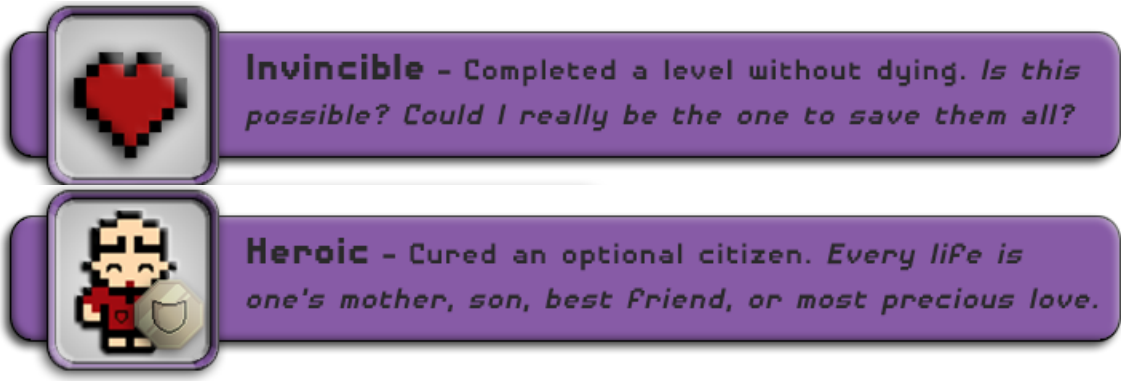
Moonwalker - Pressed both arrow keys at once.
Exploration and creativity will lead us to victory.

Pacifist - Completed a level without killing anything.
Are they evil, or has THOR forced their role?

Time Traveler - Completed a level with more time than you started with. *Is time an illusion?*

Violent - Tried to attack a helpful NPC. *They believe in you! This is how you use their trust!?*

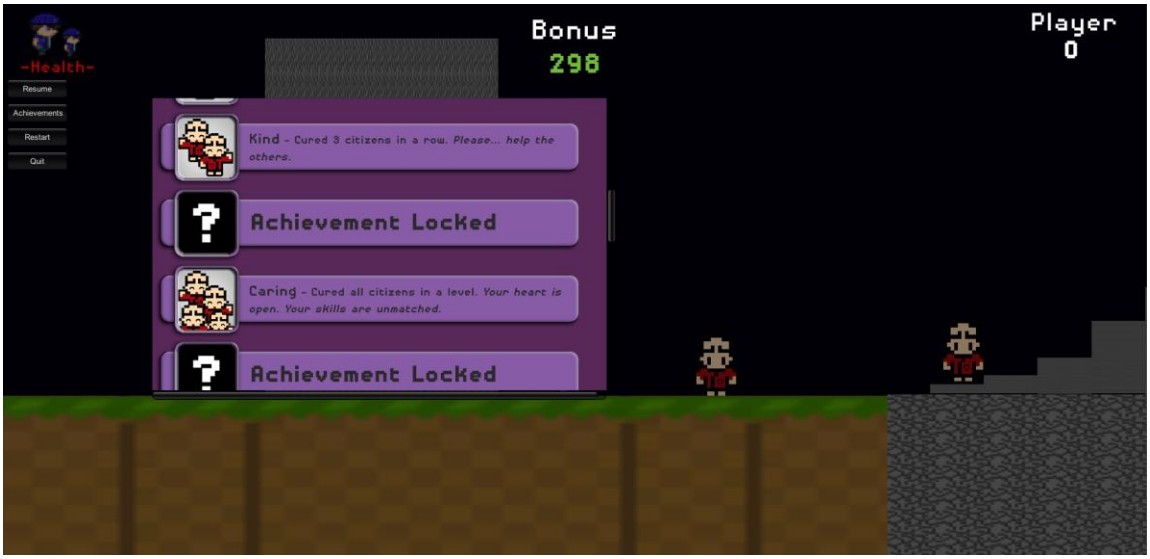
Dedicated - Killed self while a minion of THOR.
NONE shall survive! Even if it means.... this....


Invincible - Completed a level without dying. *Is this possible? Could I really be the one to save them all?*
Heroic - Cured an optional citizen. *Every life is one's mother, son, best friend, or most precious love.*

APPENDIX L: ACHIEVEMENT AWARD INTERFACE


erry's Veterinarian
Now it is time for me to continue my journey. Farewell. Stay in touch.
Achievement Unlocked!
Savior of A Planet

APPENDIX M: ACHIEVEMENT LIST INTERFACE


-Health-
Resume
Achievements
Restart
Quit
Bonus
298
Player
0
Kind - Cured 3 citizens in a row. Please... help the others.
Achievement Locked
Caring - Cured all citizens in a level. Your heart is open. Your skills are unmatched.
Achievement Locked

APPENDIX N: UCF IRB APPROVAL LETTER

University of Central Florida Institutional Review Board
Office of Research & Commercialization
12201 Research Parkway, Suite 501
Orlando, Florida 32826-3246
Telephone: 407-823-2901 or 407-882-2276
www.research.ucf.edu/compliance/irb.html

Approval of Human Research

From: **UCF Institutional Review Board #1**
FWA00000351, IRB00001138

To: **Joseph R. Fanfarelli**

Date: **May 23, 2014**

Dear Researcher:

On 5/23/2014, the IRB approved the following human participant research until 5/22/2015 inclusive:

Type of Review:	UCF Initial Review Submission Form
Project Title:	The Effects of Narrative and Achievements on Learning in a 2D Platformer Video Game
Investigator:	Joseph R Fanfarelli
IRB Number:	SBE-14-10321
Funding Agency:	
Grant Title:	
Research ID:	N/A

The scientific merit of the research was considered during the IRB review. The Continuing Review Application must be submitted 30days prior to the expiration date for studies that were previously expedited, and 60 days prior to the expiration date for research that was previously reviewed at a convened meeting. Do not make changes to the study (i.e., protocol, methodology, consent form, personnel, site, etc.) before obtaining IRB approval. A Modification Form **cannot** be used to extend the approval period of a study. All forms may be completed and submitted online at https://iris.research.ucf.edu .

If continuing review approval is not granted before the expiration date of 5/22/2015, approval of this research expires on that date. When you have completed your research, please submit a Study Closure request in iRIS so that IRB records will be accurate.

Use of the approved, stamped consent document(s) is required. The new form supersedes all previous versions, which are now invalid for further use. Only approved investigators (or other approved key study personnel) may solicit consent for research participation. Participants or their representatives must receive a copy of the consent form(s).

In the conduct of this research, you are responsible to follow the requirements of the Investigator Manual.

On behalf of Sophia Dziegielewski, Ph.D., L.C.S.W., UCF IRB Chair, this letter is signed by:

Joanne Muratori

IRB Coordinator

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