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A proposed model for designing children's health-focused serious games

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by

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GLOSSARY OF GENRES & TERMS

Games have been around for centuries, and so has the language used to describe them. It can come as no surprise, then, that today's jargon differs greatly from circle to the next. The terms at the end of this section have been included to provide a more formal list of game terminology. A list of educational and medical terminology has also been included to clarify several points made in this paper.

Understanding the genres helps designers and developers determine how to structure interactions and better shape the game experience to suit the player's needs. It allows them to assess game content, as well as aspects of the player's experience such as visual perception, beliefs, decision-making, and social interaction within the game's domain.[1]

There are many ways to classify games. The task grows complicated fairly quickly. Games may be classified by genre, game genre, environment, narrative, number of players, and modes of interaction. Genre gives a category, such as puzzle, or adventure games; game genre describes the gameplay categories, such as matching puzzle games, brain training educational games, or role-playing adventure games.[2] There are countless sub-genres of games, too, making the task of categorizing them incredibly difficult. Dissection of the genre becomes an acute science, producing something like this:

online	multiplayer	shooter	role playing game (RPG)
Environment	**Player #**	**Game Genre**	**Genre**

Fortunately, the Information Resources Management Association has formulated a condensed list of game genres based on the research of game gurus Jim Gee, Kurt Squire, and Brenda Laurel.[3] This list includes action/shooter games, fighting games, role-playing games (RPGs), simulations, strategic games, parlor/party games, sports games, rhythm/dance games, platform games, and adventure games.

Disney Imagineer and game design pro Scott Rogers adds augmented reality, educational, and serious games to the list. He also places puzzle games and "traditional games" in their own categories. The genres are detailed further in the following pages.

Game Genre	Objectives
action/shooter	emphasize speed, aim, accuracy, target hits, and agility; combat
adventure	focus on resource management, problem-solving, and task completion
fighting	to compete with characters of similar skill, or to demonstrate mastery
role-playing game (RPG)	form of adventure game in which players assume specific roles in play
simulations	to understand, practice, and/or learn procedural or relationship skills
strategy	to use logic and foresight to form a plan, while also managing resources
party/parlor	to facilitate interaction and competition between multiple players
sports	to learn the rules and strategies underlying athletic games
rhythm/dance	to control spatial and kinesthetic movement in response to sound or music
platform	to maneuver over obstacles or between platforms to complete a level
augmented reality	to incorporate reality and virtual environments for more immersive play
educational	to educate in an entertaining way; play and learning not well integrated
serious game	a game which integrates learning with play to foster behavior change
puzzle	to improve logical reasoning, observation, and pattern recognition
traditional	a digital adaptation of a non-digital game, such as solitaire

** Objectives defined using Scott Rogers's chapter, "Game Genres"[4]*

Glossary of Terms

A general understanding of the terms that follow will help in understanding the process and methodologies presented in this thesis. Definitions marked with an asterisk are summarized from the *Oxford English Dictionary*.

Gaming

actor	a character, main or otherwise, designed into a game
game	a form of play guided by rules
video game	any electronic game requiring a screen and player input
gamer	a person who plays games, usually one who plays video games
play*	an activity chosen for enjoyment or recreational advancement of skill
gameplay	the act and aspects of playing a game, esp. a computer game
nube	(*slang*) one who is playing a game for the first time, a “newbie”
serious game	a game that balances behavior change with elements of fun
edutainment	a game in which play is used as a reward, secondary to learning
epic win	an intensely impactful, thrilling win; triumph, as opposed to victory
finite game	a game that has a definite end and conclusion
infinite game	a game without a clear end, which provides continual challenges

Medical Terms

type 1 diabetes	an autoimmune disease that requires use of insulin
type 2 diabetes	a metabolic disorder caused by decreased insulin sensitivity
insulin	a hormone that metabolizes and regulates glucose in the blood
A1c	a test indicating average blood glucose levels over 3 months

Learning Terms

juvenile	any child under 18
adolescent	usually used to describe a child between the ages of 12 and 18
constructivism	an educational theory that maintains knowledge is constructed
behaviorism	a theory that maintains learning results from conditioned behavior
reinforcement	something used positively or negatively to encourage a behavior
near transfer	application of knowledge or skill in similar contexts
far transfer	application of knowledge or skill in a dissimilar context

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ABSTRACT

Rising incidence of chronic health problems among children demands greater consideration of children as primary users of health learning materials. Current formats of this information may not be suitable format for their needs. Video games present a more viable option for understanding complex health concepts underlying such conditions.[22, 90] Serious games in particular may fill this need, however there are few resources specific to the design of health-focused serious games. Learning, gameplay, and usability are all important components of serious gaming. A thorough analysis of 12 models used in each of these disciplines guided development of a new 15-point model, which was then applied to several existing game. This new model is proposed as a tool for game designers in developing, evaluating, and predicting the success of future health-focused serious games throughout the game development process.

CHAPTER 1. INTRODUCTION

When I began work on my thesis I knew two things: 1) I wanted to investigate the role of play and interactivity in learning; and 2) I wanted to use my research to create something that would help others use play to transform the learning experience.

I had been working on an idea for a game to help newly diagnosed kids with Type 1 diabetes. Further investigation into the state of children's health education revealed that while new methods of facilitating this learning had grown and improved markedly over the past 20 years, there was still ample room for growth. Adults have health apps, smart gadgets, and online communities. These tools have all proven very effective in improving their health and wellbeing[5]—but kids need and deserve something better.

Educational materials for parents and newly diagnosed children with Type 1 Diabetes are often overwhelming. These materials are frequently confusing, outdated, or overly complicated. Furthermore, it is often poorly designed. All too often they neglect the child's personal needs. Information targeted to the parent, not the child, creates a disconnect that may negatively impact the child's ability to care for him- or herself later. That's when I approached video games.

Video games have been utilized to promote wellbeing among adolescents for many years, diabetics included. In fact, since 1992 there have been many video games released to help youngsters learn to self-manage and achieve better glucose control.

Most of these games are designed to increase knowledge, using A1c levels to determine the correlation between gameplay and glucose control. As a result, few studies have explored how these games may be used to promote positive health behaviors among children living with Type 1 diabetes. Glucose control is certainly a major goal of treatment, but it is something that fluctuates as a child matures and gains experience. Effort and improvement should be emphasized more than results. Games should be designed first and foremost to teach children how and what they can do to improve self-management. This concept is at the very heart of health-focused serious games. Health-focused serious games present a unique challenge: they are specifically designed to promote behavior change.

The recent explosion of the gaming industry demonstrates how effective games can be in facilitating learning for players in almost any sector of the market. It is especially promising in education, where games are teaching a range of subjects from genetics to civics to mathematics, and everything in between. There is abundant research on developing models for designing commercial games; similar models are emerging for educational and serious games as well. Research on health-focused serious games is also becoming more widely available, however many experts argue that serious games still fail to adequately balance learning objectives with the entertainment value of commercial games. A more clearly defined model may provide better guidance for developing these niche games.

In order to develop such a model, I have examined 12 existing models for both commercial and educational games, as well as models for learning and usability.

Aspects of each have been synthesized to propose an evaluative model for health-focused serious games. To demonstrate how this model may be used, it model was applied to several games: one commercial game, one health-focused serious game in a separate domain (cancer), and three within the same domain (diabetes).

1.1 Why diabetes? Chronic illness in context

Good health begins with clear understanding (education) and a level of control (behavior). Health is a complex topic, and the simple truth is most health information is just not kid-friendly. As the global population grows, so, too, do many of the problems we face. Rates of asthma, obesity, kidney disease, cystic fibrosis, cerebral palsy, and some cancers have all increased in the last decade. One report by the Center for Child and Adolescent Health Policy indicated that as many as half of children in the U.S. have had to live with a chronic condition for a period of at least year. Most children recover within a period of six years, but up to 7 percent may live with chronic health conditions permanently or semi-permanently.[6] This clearly demonstrates a need for improved health learning resources for children.

We are in the midst of what the WHO calls a global financial health crisis. At the forefront of this crisis is diabetes, something that has increased in prevalence among the young and old alike. The consequences of poorly managed diabetes can be debilitating. The longer an individual lives with this disorder, especially in poor control, the greater likelihood that he or she will experience negative consequences. This is especially alarming considering the rate of diabetes among American youth alone is

expected to double and possibly quadruple by 2050.[7] The American Diabetes Association estimates that by 2050 a third of our nation's adults will be living with diabetes. (Fonseca, ADA) It is expected to jump from 366 million to a whopping 552 million globally in the next 15 years. Clearly this issue demands our attention.

The good news is the increasing prevalence of diabetes has been met with significantly improved management tools. In a span of 40 years we've developed more compact insulin pumps, injection pens, continuous glucose monitoring devices not much bigger than a quarter, and are working on smart watches and contact lenses that will monitor blood glucose levels. There are many apps that help users count carbohydrates and calories, keep track of weight, and log exercise. Health technology is among the most rapidly growing industries on the planet. Thanks to the upswing in diabetes, the future of glucose management tools is looking bright.

The downside is, despite their similarities, Type 1 and Type 2 diabetes *are* different. Type 1 requires more aggressive treatment, and must adapt to the needs of a much younger demographic. Current tools and methods of instruction may not address their needs. Put simply, the tools, treatments, and training specific to Type 1 are struggling to keep up with their counterparts. The population affected by Type 1 diabetes is an excellent focal point for the development of health-focused serious games because it primarily affects children.

When discussing diabetes most people think of Type 2, but there are, in fact, at least half a dozen variations. For the sake of simplicity these can be categorized as Type 1, Type 2, or Gestational diabetes. Prediabetes and gestational diabetes are often

precursors to Type 2. Juvenile (Type 1, childhood onset) and latent autoimmune or monogenic diabetes (slowly progressing, adult onset) are both subtypes of Type 1.[8]

Type 2 diabetes is a metabolic disorder in which the body becomes resistant to insulin, meaning that the cells produce but cannot use insulin efficiently. Type 2 is often comorbid, present with other chronic health conditions in mature adults. Individuals may be genetically predisposed to the condition, but it often develops as a result of poor diet or lifestyle. Type 1 diabetes, in contrast, is an autoimmune disorder.[9] Type 1 diabetes occurs when the body destroys the insulin-producing beta cells (islet cells) that regulate blood glucose.

Elevated glucose levels characterize both types of diabetes, but they are very different conditions with very different treatments. In some ways Type 1 is enigmatic. It peaks near puberty, but recently cases among very young children and young adults have increased.[10] It does not discriminate by gender, affecting males and females equally in childhood but more common in males into early adulthood. It is not preventable, and it is not reversible. It cannot be cured, but effects can be reduced with good management.[10]

While the world has trained its attention on Type 2 diabetes, Type 1 is also on the rise. It was once thought to be relatively rare, affecting less than 1 percent of the world's population. The endocrine disorder currently affects as few as half a million children globally.[11] Even this estimate seems conservative considering 79,000 American children were diagnosed in 2013 alone.[12] Experts estimate that as many as 3 million Americans may currently be living with Type 1 diabetes (T1D), roughly 109,000 of whom are

children.[11] They predict an additional 15,000 children and 15,000 adults will be diagnosed annually.[13] The most recent report by the Juvenile Diabetes Research Foundation has revealed several peculiar trends in prevalence of T1D. In the last decade, its prevalence among persons under the age of 18 rose 23 percent. The JDRF has also reported a higher incidence of adult onset T1D, and an especially marked increase in diagnoses among children aged 14 or under, indicating that diabetes is also becoming more prevalent among young children.[14] Recent findings by the International Diabetes Foundation indicate that these findings hold true in other countries, as well. The IDF believes T1D incidence among adolescents 14 and under will continue to increase 3 percent each year globally. [15]

1.2 A whole new game: Understanding and coping with chronic illness

Treatment for Type 1 is much more complicated because the body eventually ceases insulin production. The first years following a child's diagnosis is likely to be characterized by much more frequent doctor's visits, stricter dietary restrictions, and treatment adjustments. The first years and the years during puberty are likely to be marked by insulin sensitivity as dosages must be rebalanced as hormone levels fluctuate. Treatment can be embarrassing and painful, not to mention incredibly complicated. In addition to frequent finger pricks and daily injections, social stigmatization and financial burden may contribute to fear and anxiety among newly diagnosed children. This can make it even more difficult to regulate glucose levels, which ironically compounds the likelihood of complications.[16]

Learning to manage a new chronic illness can be a struggle; taking on that level of responsibility can be daunting to the even most competent adult, let alone children. Unlike people with Type 2, all people living with Type 1 diabetes must take insulin to survive. Establishing an aggressive and effective regimen will help newly diagnosed people with diabetes (PWDs) learn to adapt and cope with the disease. It requires constant care and attention, and it usually requires major lifestyle changes. It can affect other aspects of the individual's life, too, as it may cause difficulty in schooling and put strain on family.[17]

Managing a chronic illness requires almost constant attention to master. Treatment must be tailored, and getting it right takes time. That means failure, and the unfortunate truth is the more a course of action fails the less likely it will be repeated. Treatment that focuses on medications used to treat a condition are much better when supported by a more holistic model that also supports a patient's emotional and mental health.[18] Learning resources should help individuals move toward a place of acceptance and empowerment. They should acknowledge that mistakes are inevitable, and help patients push past failure and toward perseverance. The quality and availability of resources are important in this regard, so finding resources that meet the patient's personal needs becomes valuable.

1.3 Playing doctor: The potential of play in healthcare

Jane McGonigal, a research affiliate at California's Institute for the Future, is an expert on the potential of games. Her research revolves around video games of all

types, and she suggests that life is merely a series of games that help us move through difficult times. She maintains that video games satisfy genuine needs, suggesting the booming gamer culture has only grown as a result of this phenomenon. While she acknowledges the possibility that gamers may lose touch with reality, she also acknowledges the power of gaming to stimulate, motivate, and engage them.[19]

In her book, *Reality is Broken*, Jane McGonigal gives a simple explanation for the recent gaming craze: “Reality doesn’t motivate us effectively,” she writes. “Reality isn't engineered to maximize our potential. Reality wasn't designed from the bottom up to make us happy."[20] In the case of healthcare, the reality is children’s health education is still largely stuck in the past.

Past research has produced mixed results as to whether education really improves glucose control among individuals living with Type 1 diabetes. The wide range in lifestyle, quality of care, and response to treatment makes it difficult to say which variables affect the results of these studies. What researchers can agree on, however, is the importance of education on understanding the disorder and how to manage and cope with it. The International Society for Pediatric and Adolescent Diabetes (ISPAD) is one of the leading organizations in establishing healthcare guidelines for patients and practitioners alike. The organization argues education is the cornerstone of care. In fact, they suggest frequent education and re-education be made a regular part of the diabetes healthcare regimen. They indicate that this is particularly important in pediatric treatment, when children first learn the skills that will carry them through life. [21] Such skills can be acquired and developed through gameplay.

Play can be a very effective tool in coping with some of the mental and emotional stress of a chronic illness. The flexibility of video games offers countless opportunities to learn about conditions such as diabetes through play, with the added benefit of transferring more complicated concepts. A clearly defined model for designing health-focused serious games may improve children's health learning by more effectively mapping objectives and creating a more positive play experience.

1.4 Goals of thesis

- To conduct a thorough analysis of existing models of educational and game design;
- to produce a model for creating "good" serious games by analyzing both commercial and educational games; and
- to find the apex at which the psychological aspects of learning, usability, and play converge to develop a serious game that facilitates learning and behavior change.

Research questions

1. What makes a good game?
2. What factors of play, usability, and learning are most important to map into games designed for increasing understanding and promoting behavioral change?
3. How might existing models be incorporated and adapted to design an evaluative model for health-focused serious games?

CHAPTER 2. LITERATURE REVIEW UNDERSTANDING THE RELATIONSHIP BETWEEN LEARNING, PLAY, AND USABILITY

The relationship between learning, play, and usability in gaming is complicated, but understanding it is paramount to creating a high quality experience. This is especially true of serious games, which rely on balancing carefully mapped learning objectives with fun to promote behavioral change.

Debra Lieberman, Assistant Professor at the University of Southern California at Santa Barbara and Director of the national Health Games Research program, is one of the foremost researchers in the health-focused serious game industry. According to Lieberman, serious games are in fierce competition with commercial titles, not to mention other forms of entertainment because players aren't required to play them. Unlike a lesson in school, players must choose them over other leisure activities. This makes designing the experience incredibly important. "They must be engaging, either because they are fun, cool, social, interesting, or entertaining, or because they offer other gratifications," she writes.[22] This isn't something a lot of educational games can accomplish.

Serious games cannot and should not be expected to replace more traditional educational models. Instead, they should be used to supplement them. "Since leisure-time games are supplements," Lieberman continues, "a relatively ineffective serious game would not be a major problem."[23] This alleviates some of the pressure put on

serious game designers, allowing them to focus on the experience and better balance learning with fun.

Jane McGonigal, Director of Game Research & Development at the Institute for the Future in Palo Alto, offers game designers a valuable piece of advice: “To understand the future, you have to look back at least twice as far.” [24] Past success of health-focused serious games indicates that they do, in fact, hold great promise for helping children understand their health. Learning, play, and usability are all integral components of game design. As such, they must be carefully considered.

The literature review that follows identifies the strengths and weaknesses of traditional education, as well as practices that promote learning. The role of play in the learning process is also detailed, with special attention given to video games, flow, and immersion. This chapter concludes with an examination of users and usability, and how consideration of each promotes behavioral change in health-focused serious games.

2.1 Learning

In his book, *The Anti-Education Era*, gaming guru James Paul Gee of Arizona State University explains how people are hardwired for learning. He says we are programmed to act, learn from our actions, and then apply what we've learned from our experiences to other similar scenarios. All of this occurs in the mind.[25] For this reason, we possess a unique ability to exercise foresight. We are able to break apart action sequences and their outcomes, and store them for future use. As experience grows, we are able to apply knowledge in incrementally abstract ways. This is due to our superpower: imagination. Interestingly enough, Gee explains, they work a lot like video games.[26]

2.1.1 Education and learning

It is important to note that there is a difference between education and learning. While the terms are related, they are very different things. Education, as defined in the *Oxford English Dictionary*, refers to "systematic instruction, teaching, or training in various academic and non-academic subjects given to or received by a child."[27] It sounds more like a punishment than a tool for expanding our horizons. Learning, on the other hand, is "acquired by systematic study." It is defined as "the action or receiving instruction or acquiring knowledge, a process which leads to the modification of behavior or the acquisition of new abilities or responses."[28]

Mary Kalantzis, researcher and Dean of the College of Education at the University of Illinois, suggests optimal learning occurs when formal and informal learning overlap. That is, when knowledge is constructed in environments in which learners are given information and then encouraged to try, test, and challenge it through exploration and application.[29] She tells us the most important conditions for impactful learning are the ability to engage a learner personally, and an opportunity to improve skill or expand understanding.[30] Finally, she tells us these factors are greatly affected by a sense of belonging that motivates a learner to invest in the learning process, giving the player an opportunity to use what is learned to transform his or her experience.[31] This distinction between formal and informal learning is one of the foremost considerations in game design because the strategies of formal learning and the interactivity required to facilitate informal learning must be carefully integrated into serious games.[32]

Kalantzis believes formal education is in the midst of a crisis. She maintains that current educational techniques have more to do with guesswork than actual learning. Book smarts, for example, may carry a person through the educational system only to find them lacking the ability to adapt and apply that knowledge practically in a real world environment. Conversely, people with so-called street smarts may lack understanding of the theory that informs and improves certain processes.[33]

Despite high investment in primary and secondary education, students are taking much longer to complete basic coursework. Once they do, only about one in five (22%) are adequately prepared for college. Less than half of the students who do continue their education are prepared to take on the workload once they arrive to campus.[34] This

has a major impact on many aspects of American life. In addition to an under-skilled workforce, it may also pose a threat to our ability to solve problems and innovate. Just 74 percent of today's highschoolers will graduate—that's down from 80 percent in the 1970s.[35] While America's youth were among the top students in the world just a decade ago, we as a nation have failed to reach even the top 10 in reading, math, or science.[36]

Many of these figures are based on standardized test scores—something that's generally considered a poor practice—but findings based on other factors such as educational attainment support these trends. Iowa, for example, used to be a national leader in primary and secondary education. Until the early 1990s, Iowa's high school students were top scorers in both reading and math.[37] In the 20+ years between then and now our students have failed to make significant growth in these areas. In fact, the number of university students who finish their degrees has dropped. Our state has one of the lowest rates of Bachelor's degree ownership in the Midwestern region.[38] In a 2011 speech, U.S. Secretary of Education Arne Duncan stated that Iowa trails 20 other states and more than 30 countries in education. He pointed to a lack of flexibility and openness to experimentation in our classrooms.

Professor Robert Gordon of Northwestern University shared similar sentiments in a recent article for *The New York Times.* "Federal programs like No Child Left Behind and Race to the Top have gone too far in using test scores to evaluate teachers (and students)..." he wrote. High school graduation and degree attainment are again on the rise, but the most marked improvements are found in charter schools where alternative teaching and evaluative methods have all but erased disparities in achievement among

minority and low-income students and students attending more elite schools. “This model,” he continues, “suggests that a complete departure from the traditional public school model (is needed)…”[39] Our educational systems are failing—it’s time to level up.

2.1.2 Constructivism and behaviorism

There are countless ways to learn, but when it comes right down to it, it’s the *type* of learning that occurs that is important. Here we turn our attentions to two types of learning: incidental and intentional. The former is more casual, frequently occurring in the exploratory activities that come with play, while the latter is more prominent in formal schooling environments. A thorough understanding of both is essential to understanding their role in gaming.

Formal education as it exists today is supported by many theories, however a great schism seems to exist between constructivism and behaviorism. Constructivist theory maintains that the formation of knowledge is constructed based on ideas and experiences. Construction occurs naturally in informal learning environments, where learning is often incidental. This type of learning is well suited to play.

Renowned psychologists Jean Piaget and Lev Vygotsky are among the foremost proponents of constructivism. They held similar beliefs, however their approaches differed greatly. Piaget's work grew from the sciences, while Vygotsky's grew from the arts.[40] Both held that learning is attained through learners’ constructions of reality. Piaget, long held as the father of modern constructivism, supported a highly individualistic approach. He more closely examined how an individual child learns

through doing. Equally renowned Vygotsky felt that learning was very much informed through social interaction.[41] Both established models to guide children's education based on a child's developmental stage.

TABLE 2.1, Piaget's Stages of Learning [42,43]

Piaget's approach is more linear, defining stages by age and development, while Vygotsky's zones are more general and focus on social learning in young children. His theory of proximal development expands upon Piaget's stages, demonstrating the way children of different ages and skill levels learn from each other. For example, a child in Piaget's concrete operational stage is likely to have a basic understanding of soccer. The child would be able to teach younger children how to play or involve them in a version with fewer rules—perhaps a simple game of kickback. This same child would also be able to understand a different set of rules when playing with a parent or older sibling. The child may choose to engage in play with the sibling to improve, but will most likely not choose to fully engage an adult. Instead, the child may focus on learning skills from a parent who has mastered fundamentals. This child would be learning in Vygotsky's *zone of proximal development*.

This style is a more informal approach to learning. In this model, the child operates at or slightly above his own degree of competency. He learns a slightly higher level of skill found between what he has already mastered and what is beyond his current ability. Through proximal learning, understanding can be constructed through the experience of others, as well as the learner's personal experiences. This is different from behaviorist learning.

Behaviorism maintains that learning behavior(s) occurs through conditioning and either positive or negative reinforcement.[44] The way these reinforcements should be used is entirely dependent on the desired outcomes. Reinforcements can be thought of as sticks or carrots. If the objective is to change a behavior, negative reinforcements

such as punishment (sticks) are used to encourage the actor to act differently. Positive reinforcements or rewards (carrots) are used to encourage repeating a behavior.[45] As the subject continues to experience favorable consequences as a result of his or her actions, the greater the likelihood that specific course of action will recur.[46] This process, is called conditioning. Russian physiologist Ivan Pavlov first investigated the conditioning process in the early 1900s. These methods would never succeed on their own if used in games. Fortunately, the Pavlovian “sticks or carrots” approach only represents one end of the behaviorist spectrum.

B.F. Skinner was Professor of Psychology at Harvard University in the 1960s whose research focused on social psychology and behaviorism. His perspective on educational behaviorism is that people essentially learning through action and repetition. This is true to a degree, but learning this way isn’t likely to yield lasting results. "Most reinforcements occur intermittently…When the ratio of responses to reinforcement is favorable, the behavior is commonly attributed to (1) diligence, industry, or ambition, (2) determination, stubbornness, staying power, or perseverance (continuing to respond over long periods of time without results), (3) excitement or enthusiasm, or (4) dedication or compulsion."[47] As time passes, and as the frequency of positive reinforcement declines, the diminished return decreases the likelihood of repeating the behavior also declines.

There is a longstanding debate in education as to whether constructivism or behaviorism holds the greater advantage in learning, but the two are not mutually exclusive. In fact, quite the opposite. Skill and drill methods are simply not as effective

on their own. A certain degree of conditioning may help initiate positive behavioral change, but these changes must be supported by constant positive reinforcement. This presents a challenge, for as we've established, health isn't consistent.

Combined with constructivist techniques, behaviorism can be very effective, especially if the reinforcement causes the subject to become internally motivated. Skinner explains that as the actor is met with success (continuous positive reinforcement), his or her self-confidence and mastery also increase. They become empowered.[48] Serious games require transfer of both knowledge and behavior—a constructivist grasp of "what" and "why", balanced with a behaviorist sense of "how" that leads to specific actions.

2.1.3 Why games are different

What is it about games that make our hearts leap? Is it the small triumph of a job well done, or is it the sense of satisfaction found in knowing success will be secured? "Games are something special and unique. They are concentrated chunks ready for our brains to chew on," explains Raph Koster, game design expert and author of *A Theory of Fun for Game Designers*. "Usually, our brains have to do hard work to turn messy reality into something as clear as a game is. In other words, games serve as very fundamental and powerful learning tools."[49] The ability to manipulate actions and observe the consequences in a relatively shortened amount of time gives gaming an advantage over many lab-based learning environments.

Games get a bad reputation from a handful of games with extreme content and tragic events. Devastating violence and cases of severe addiction in the news haunt many parents and educators. Even in educational gaming many adults hesitate to give games the credit they deserve. For example, some "critics have raised valid concerns that what players learn from games is not the properties of complex systems but simple heuristics..."[50] This may be true in some, but certainly not all cases.

Games can teach us so much about life, show us new ways of thinking, expose to new ideas. They can help us learn to strip away the unnecessary to focus on what's important. Koster explains that games, as models of reality, can prepare us to face real obstacles.[51] Testing skills and judgment in gaming there is the potential to prepare us for many scenarios. It should be logical, then, learning and play should not be separated. At least that's what Gee maintains.

Learning is the motivation, the challenge, and the reward of play. "Real learning is always associated with pleasure and is ultimately a form of play—a principle almost always dismissed by schools," Gee maintains. "There is one crucial learning principle that all good games incorporate that recognizes that people draw deep pleasure from learning and that such learning keeps people playing." [52]

Like Gee, Koster believes that games are play patterned on real-world scenarios. Koster, however, argues that games are not merely made of components of stories. He explains that "(games) have more in common with how our brain visualizes things than they do with how reality is actually formed..." We learn the patterns and processes behind scenarios and the problems they present, and adapt a very simplified model of

how to apply the resulting solutions to a variety of similarly structured problems. When presented with any one of these problems, we are able to apply what we've learned from game play fairly intuitively. "The only real difference," Koster continues, "is that the stakes are lower with games."[53]

Traditional schooling requires children to sit still for hours at a time, confined at extended lengths for their daily lessons. The time structure of traditional schooling presents problems that gaming would not. Games are designed for extended play. A finite game takes anywhere between 20 and 50 hours to complete.[50, 52] Infinite games such as *World of Warcraft* with many opportunities for mastery and endless quests may go on forever.

Gee agrees: "Current research on learning supports the sorts of learning principles that good games use, though these principles are often exemplified in games in particularly striking ways. However, many of these principles are much better reflected in good games than in today's schools..." Testing, he adds, is particularly problematic in this respect. [54] For example, emphasis in games is placed on effort and mastery rather than performance.

Unlike most learning in the classroom, players may move at their own pace and attempt or re-attempt a challenge as many times and at almost any level of difficulty as they choose. Instead of rushing to keep up with other students and advancing prematurely, they are rewarded for perseverance and true mastery, and they’re rewarded with yet another challenge. What’s more, players may challenge each other—or help each other—encouraging them to experience content as both novice and

master. Lieberman, too, points to a constructivist model of learning because it is internally motivated by a desire to understand and succeed, not a fear of failure. “(It) is more likely to be experienced as fun when there is a good reason to learn, the material is tailored to the individual learner's abilities, the system provides helpful feedback and support, and the learner has some personal control over the process."[55] This incidental learning, she writes, is better than the “stealth learning” found in edutainment-type games which leave teacher and student dissatisfied. Incidental learning is more visible without being watered down or diluted. “(The lesson is not) hidden behind some frothy entertainment that sugar coats the learning to make it invisible or at least more palatable. Instead, learning is front and center as a process to enjoy an achievement to be proud of.”[56] It’s a completely different mindset. This is why serious games are effective.

2.1.4 The view of games in traditional education

Games in education haven’t been as well received in the classroom as most game designers would like. Many educators are still hesitant to bring them into the classroom. The problem with most educational gaming is that students have caught on to stealth learning. This occurs when play and learning are not successfully integrated. Subjects are too often gamified without properly engaging the students. In gamification play is used as a reward for learning instead of as an integral part of learning. Students don’t learn well this way—Can you blame them? Teachers don’t reach bored but otherwise motivated students. It becomes a draw, and nobody is pleased.

All games are supposed to be fun, but not all educational games are. This is because many educational games have lost some of their spontaneity and abstraction. They become more like simulations, which teach concepts and processes very methodically. These games lack that engaging sense of discovery and play that characterizes informal incidental learning. They quickly become boring, and students no longer wish to play. The result is an ineffective game.

Educational games have improved over the years, though they have yet to reach a level of success comparable to their commercial counterparts. Serious games, on the other hand, are a different story. As supplemental parts of health education, they have more freedom than educational games guided by strict lesson plans. The most important part of the serious game design process is mapping concepts in a way that implicitly delivers the lesson. This only works as long as it takes kids to catch on.[57]

2.1.5 How gaming fits into health education

Methods of health education have become more fun, but it still *looks* like educational material. “Education (is) the cornerstone of diabetes management, suggesting that it should be a lifelong process and that children and young people with diabetes should be provided with information and a structured programme.”[58] Education, assessment, and re-education are recommended. Kids may choose from a wide selection of workbooks, flashcards, DVDs, and stories with diabetic protagonists—options run the gamut. Each of these formats has its advantages, but none so many as

games. However, problems with traditional health education for kids are much the same as those found in the classroom.

Traditional formats work wonders in increasing knowledge, but they aren't always effective in promoting changes in health behavior.[59] Above all, the ultimate objective of any diabetes education regimen is to promote measurable behavior change. This can be measured in a number of ways. Most studies of games in diabetes education use A1c levels as a metric for indicating success. This becomes another point of conflict between pro- and anti-gaming researchers.

Gaining control of glucose levels is difficult, and the amount of time it takes to achieve target levels varies from person to person. Each person is also believed to have a unique ideal glucose range.[60] Treatment must be tailored to the individual. Learning these skills while also getting the treatment regimen right takes time. As a child matures treatment will have to be adjusted to keep up with changing lifestyle and body chemistry. That means that sometimes doing the same things will not produce the same results. That means failure, and the unfortunate truth is that the more a set of actions fails the less likely they'll be repeated. It can be incredibly discouraging. Rewarding a child for good glucose levels may be effective initially, but it's not likely to produce the long-lasting results caregivers desire. It's no wonder these games are not more successful. Evaluating them this way completely belittles the *effort* a player puts into making positive behavioral changes.

Tracking glucose levels is undoubtedly an important form of measurement, but it is just one aspect of a more complicated system. According to the American Association

of Diabetes Educators, there are at least six other specific behaviors that should be encouraged. These include such habits as following a healthy diet, exercising regularly, problem solving, and developing healthy coping mechanisms.[61] If education and re-education are crucial to the process, and if play promises to hold attention, then gaming appears to be a logical fit for health education.

Gaming has a proven track record in learning, though information regarding its effects on behavior is less common. One study by Brown and Lieberman in the late 1990s demonstrated that games could indeed improve self-care behaviors. The study chronicled the effects of a health-focused game titled *Packy and Marlon*. Not only did players demonstrate better response to treatment, but they also exercised greater independence and improved communication with parents and health care providers.[62] Another report in 2001 indicated greater advantages in gaming than formal education.[63] The most important thing is to find a format that will be age-appropriate, and one that will present the information in an easily understandable format.

A serious game is the most highly recommended for pediatric health education. Serious games are games in which fun and behavior change are integrated.[64] Finding an effective parallel between objectives and play can be tricky, but designed properly they are quite instrumental in promoting quality learning.

2.2 Play

The division of work and play among children came about in the second half of the 20th century when society began to allow children more autonomy.[65] David Elkind, a psychologist and Professor of Psychology at Tufts University, has conducted extensive research on the use of play learning. "Play," he tells us, "is not a luxury but rather a crucial dynamic of healthy physical, intellectual, and social-emotional development at all age levels."[66] Play is tragically overlooked in today's curriculum. Playtime is drastically reduced as children progress from one grade to the next. This, according to Elkind, is a huge mistake because children need the options and engagement that play offers. Children ages 6-12 in particular benefit from learning through play because it requires less effort.[67] "Learning is most powerful when it involves self-initiation and personal motivation...when young people play when, where, with whom, and for how long they want."[68]

2.2.1 Play and its role in learning

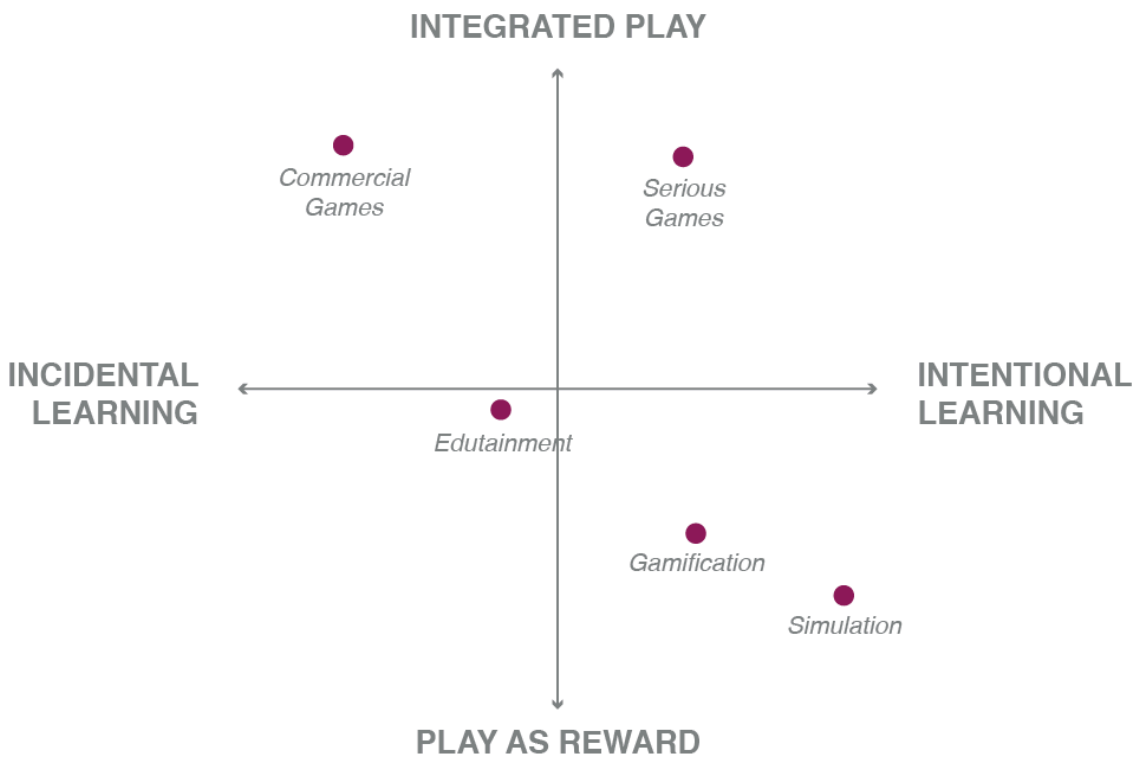
As Piaget and Vygotsky believed, knowledge is constructed through reasoning and experiences, which can be tested, tried, and proven through play. Whether this learning is incidental or intentional, players should be able to apply underlying patterns in a variety of contexts. While these theories are founded, they do not represent the full scope of learning necessary to master content and/or help the learner modify behavior.

Knowledge is, indeed, the basis for understanding, but more is needed if learners are to apply that knowledge effectively. Simply *doing* will form a more thorough understanding. “It's one thing to read in a book that 'the map is not the territory' and another to have your army rolled over by your opponent in a game,” Koster writes. “When the latter happens, you're gonna get the point even if the actual armies aren't marching into your suburban home."[69] Informal learning such as would occur through play is effective because it occurs when a learner is relaxed; “the player is likely to have chosen to play the game, sometimes with no learning goals in mind but simply for entertainment…"[70] The resulting incidental learning becomes an added bonus.

Lieberman also points to informal learning as a stronger means to enduring results.[71] This, she explains, is because informal learning entails more than attaining knowledge. It affects a player's mindset, his or her skills, behaviors, beliefs, and so on. The ability to alter behavior is especially critical to health-focused serious games, as the objectives of these games usually are intended to improve health and extend the real life of the player.[72]

We can find an obscure lesson underlying almost any experience, though what a player learns from a purely commercial game isn’t likely to be very useful. Consider a cross section between play and learning. There is a place for all types of games on the grid, but each type of game occupies a different space. On the scale of learning, serious games fall closer to informal, incidental learning and integrated play. To harness the power of play, learning must be integrated in such a way that there is no distinction between the two.

FIGURE 2.2a, Cross Section of Play and Learning



2.2.2 Engagement, flow, and motivation

Scrabble was first released in 1931 under the title *Criss-Cross*. It was created by out-of-work New York architect Alfred Mosher Butts who had developed a sudden interest in board games. More than 75 years later it remains one of the most beloved games ever created.[73] *Scrabble* is not unlike the spelling or vocabulary lessons most elementary aged children receive in the classroom, yet it is almost always the preferred option. The point of distinction is that it's an active, experiential medium. The addition of rules and constraints make it more engaging.

In his 2004 book, *Situated Learning*, Gee writes, "Good video games have a great deal to teach us about how to facilitate learning, even in domains outside games, even in school." Players *want* the challenges that come with games like *Scrabble*, and they want to learn. They want the pleasure of overcoming obstacles to achieve that coveted epic win. Unlike most traditional learning models, players actually want to play for extended periods of time. People actually *crave* the complexity and abstraction that underlying games, and Gee maintains they must incorporate good learning principles to satisfy that hunger.[74] Few other formats hold such promise.

Gee tells us the best games are magnetic because they allow players to "operate within, but at the outer edge of, their competence."[75] The game needs to challenge players while assuring them that they're improving with each attempt, making progress toward their goals. "This feeling of the game being highly challenging, but ultimately doable, gives rise to a feeling of pleasurable frustration, one of the great joys of both deep learning and good gaming."[76] The frustration of a difficult problem must be pitted against the rewards of play while allowing the player to prove to him- or herself that he or she has mastered a skill. They are usually rewarded with yet another challenge allowing them to triumph using their newly acquired skill. The resulting success and feelings of competency become a channel for engagement and a powerful motivator.

A game cannot stop there, though. It is important to also present players with challenges that require them to learn new skills, or to test combinations of new and pre-existing ones. In doing so it encourages players to construct knowledge develop strategies for future action. It becomes a cycle of "pleasurable frustration and routine

mastery."[77] Games, therefore, present an advantageous model for learning that requires the frequent education and re-education recommended by most health programs.

Koster explains this almost perfectly:

> "Consider the key difference between something like a book and different kinds of games. A book can do the logical conscious part of the brain pretty well…what a book will never be able to do is accelerate (comprehension) to the degree that games do, because you cannot practice a pattern and run permutations on it with a book."[78]

No other medium allows a player to manipulate variables this way. It is one thing to learn about the laws of mathematics, and quite another to experience them. Simply studying Euclidean geometry may not be enough for some learners to truly grasp how it works. Mapped into a game in which players calculate the time and speed needed to beat an opponent to a shared destination, it may make more sense.

In addition to putting learning objectives into context, games also lessen the stakes of failure. If this same learner fails his or her first few math tests, there may not be an opportunity to give it another try. There may be no possibility of earning those points back to improve the overall grade of the course. Games, on the other hand, generally allow a player to re-attempt a challenge as many times as he or she desires. The learner is in charge of the pace, the level of difficulty, and the method of evaluation. Learners may achieve success as they define it, and come to it on their own terms. As success is achieved more frequently, players tend to become more engaged and more motivated to achieve mastery.[79] Most educational techniques fail to engage learners so fully. This is because games have the advantage of flow.

Hungarian psychologist Mihaly Csikszentmihalyi first described the concept of flow in the mid-1970s. Flow can best be described as an optimal experience—a feeling of total harmony and engagement.[80] In the flow state, "attention can be freely invested to achieve a person's goals, because there is no disorder to straighten out, no threat for the self to defend against."[81] Flow helps an individual focus his or her energy by blocking out conflicting information and prioritizing the task at hand. The resulting satisfaction can help a person find clarity, improve quality of life, as well as build a sense of self.

Flow tells us that what we know, that the resources we have at our disposal are enough to solve a problem. This can be an incredible gift when experiencing something for the first time. In the earliest stages of such an experience, it is best to provide structure—let's say, rules—as a guide. Regular feedback will help tune actions and reactions to increase success, thus building experience, increasing confidence, and garnering a sense of mastery.[82] Csikszentmihalyi provides five steps to achieving flow:

1. Form a goal
2. Outline a method of evaluation to measure success
3. Focus on challenges—eventually challenges will be indiscernible; overcoming them will come with less effort
4. Acquire and refine the skills needed to achieve your goal
5. Continue to reach greater challenges as you move toward mastery.

The fifth and final step is the most important, because it is the call to rise up to a challenge that keeps players invested in the activity. As long as the activity continues to provide difficult but attainable challenges, flow should easily follow.[83]

According to Csikszentmihalyi, flow most often occurs when working toward a goal that is in one way or another regulated by rules. It requires concentration and effort, but also opportunities to exercise new and existing skills.[84] In flow, an individual is so concentrated on a task that he or she individual may be unable to invest attention in anything else. This is what gives games a bad reputation, but it's also what makes them effective. Flow occurs in a narrow corridor between anxiety and boredom. Operating in this zone can transform the way we process information and perceive the world.[85] Flow is a powerful motivator for this very reason.

The science behind what motivates us can be quite complicated. Motivation is defined as "the processes that arouse, sustain, and direct human behavior."[86] Motivation drives us, helps us form and aspire to ever-higher goals. It can come from many sources. Primary motivation is more direct, stemming directly from the action itself. This includes things like training to run a four-minute mile, or learning to play the guitar so you can play your favorite song. Secondary motivation, on the other hand, is indirect. Learning to play the guitar in this case might be motivated by a desire to impress someone, or to become a rock star. Yet this isn't an adequate classification system, either. Perhaps a better approach is to examine motivation by environment—through either an intrinsic or extrinsic lens.

Professor of Psychology Carol Dweck of Stanford University is an expert on the subject of mindsets. Her research specifically focuses on the science of human behavior, temperament, and what drives people to act. Dweck explains that growth-minded individuals tend to be more active learners. They are intrinsically motivated,

striving for constant improvement for their own satisfaction rather than the fixed-minded individuals who tend to focus on performance and immediate results. Learners with a fixed mindset are more likely to be extrinsically motivated. They tend to focus on the recognition and praise that come along with an achievement. Performance and results become an important part of who they are, and so they tend to form poor coping mechanisms that cause them crumble in the face of failure.[87] Mindsets can play a huge role in the learning process.

Teacher, author and educational researcher Gill Robins explains that younger children are motivated to act in a way that is pleasing to their parents and peers. This shifts to self and peers as they mature, suggesting that a parent-child approach may be effective early on, but that a child must be able to act more independently as (s)he grows and gains knowledge and experience with diabetes management. This is called self-determination theory.[88] "In the short term, extrinsic motivation produces better performance," she writes, "but once the reward is removed, performance noticeably declines. Earlier intrinsic motivation for the task is never fully recovered." In later years adolescents are less likely to respond to extrinsic motivation, so it's best to encourage intrinsic motivation from the start.

Games afford players with many opportunities to learn and to fail with relatively low stakes, making them extraordinary environments to foster the growth mindset. If lasting impact and constant improvement is what's desired, then an intrinsically motivated mindset is the best way to encourage positive behavioral change. Gaming provides positive reinforcement when a player repeats a challenge to improve mastery

and self-efficacy, scores points, or experiences what gamers refer to as an "epic win". Repeating tasks is not a necessity for winning a game. In fact, it doesn't really contribute to the overall object of the game at all. It does, however, enhance a player's confidence and sense of mastery. This reward is intrinsic, which is part of what makes games effective. Many psychologists believe this intrinsic motivation is what it takes for most to successfully change their behavior. Robins points to competency and autonomy as ways for building intrinsic motivation.[89]

Some research indicates that as competence grows, need for extrinsic motivation diminishes. Research by Doctor Pamela Kato of Stanford Hospital's Department of Pediatrics, for example, seems to support this notion:

> "Several cognitive and motivational processes are hypothesized to affect treatment adherence, including knowledge about the therapy and its relationship to health, perceptions of one's ability to influence health outcomes (perceived control), and confidence in one's ability to meet the specific demands of cancer treatment and recovery (cancer-specific self-efficacy)..."[90]

Managing a chronic illness is a lot of work, and like anything else there will be times when mistakes are made. When health and safety are on the line it is important to focus on future improvement. Effort should be rewarded, not results. Where do we see this better facilitated than in games?

2.2.3 Immersion and transfer

Part of flow's power lies in immersion. There's a reason so many video games are otherworldly. Immersion is one of the great advantages of gameplay, but it may also

be one of the most misunderstood. According to Ernest Adams, author of *Fundamentals of Game Design*, immersion may best be described as "losing track of the outside world."[91] Adams outlines four different types of immersion: spatial, tactical, strategic, and narrative.

Spatial immersion is what most often comes to mind when using the term. Immersion in the spatial sense occurs when a player becomes so engrossed in a game that he or she cannot distinguish between the actual and artificial world. Tactical immersion occurs when players are consumed by rapid, sometimes repeated decision-making. This "rapid fire" immersion requires constant attention to achieve flow. Strategic immersion in contrast pushes a player to calculate his or her next action, as well as the possible outcomes. This type of foresight requires the player's full concentration to tackle a challenge. Finally, narrative immersion allows a player to become engrossed in a story to such a degree that it seems to come to life in his or her imagination. Narrative immersion is best demonstrated in role-playing games, in which the player is an active character in the story.[92]

One example of narrative immersion is the 1996 game, *The Logical Journey of the Zoombinis*. *Zoombinis* was a software-based game released by The Learning Company in 1996. The game charged players with helping the Zoombinis escape their oppressive island home. Each of the Zoombinis was unique, which made them a great source of limits in the game. There were two possible escape routes in the game—the bayou trek to the north, and the mountain trek to the south. In order to evacuate smaller groups of Zoombinis, players had to consider their traits and needs. Players had to find

logical patterns among members of a group in order to move them closer to the final escape destination.

The Logical Journey of the Zoombinis became largely successful due to its use of narrative to engage and immerse players. As players tried to make decisions in the best interest of each group, they would become immersed in their roles as heroes and leaders. Because the logical learning objectives were integrated with the problem-solving aspects of play, players were able to focus on the actual experience rather than becoming distracted by the objectives. We see similar immersion in the health-focused serious game *Re-Mission*, discussed in a later chapter.

To better explain the phenomenon of immersion, Gordon Calleja of Copenhagen's Center of Computer Game Research explains a model of micro- and macro- player involvement essential in creating the communicative environment in which immersion occurs. It is this involvement that enables a game's design to guide a player through the game experience. "One reason for the intensely absorbing nature of digital games is the potential they have to affect players emotionally," Calleja writes. "An important difference with digital games is the way they place the player in a cybernetic feedback loop between human mind and machine."[93] It's as if the game system and the game environment become an extension of the player, making learning through gameplay more effective and experience design more complex.

While some of the considerations are similar, the player has fewer constraints because exploration is both expected and encouraged. Even the types of feedback must be more dimensional, as gameplay immersion is a highly sensory experience.

Designers must therefore account for many variables. For example, players oftentimes do not play as themselves, but as a *version* of themselves. By assuming the identity of the protagonist during gameplay, they are better able to let go of insecurities and fully engage in the experience.

Lieberman notes serious games with protagonists that share traits with the player or games requiring the player to care for another character *with* those traits are more immersive.[94] *The Diabetic Dog* is one example of how establishing shared characteristics between player and protagonist can increase learning and investment in a game. The effects of integrating health information and desired behaviors into play may go reach further than constructing knowledge and building skill. "Evidence integrated into their design has found that these well-designed games can (also) improve …self-concepts, attitudes, emotions, social relationships, social support, motivation, and many other factors," Lieberman writes.[95] Immersion makes these big promises possible through transfer.

Transfer occurs when learning in one environment or context is applied to another. "(It) might involve students learning addition through word problems," writes Eric Klopfer, Professor of Science Education and Engineering Systems at MIT. Calculating the sum of the prices of apples and oranges becomes algebra. "We may expect the knowledge to transfer from the classroom to the store, as the tasks in the word problems and grocery store are likely to be quite similar."[96] Klopfer suggests the closer play can mimic reality the better a player will be able to transfer skills from one task to the next.[97] This type of learning is incredibly powerful, but it poses several

challenges. Identifying a specific user is important to any design, but the complexity of games can make it even more difficult to assess a player's previous experience with a subject, pre-existing knowledge of the game's mechanics, not to mention the player's ability to apply the skills and knowledge he or she does have appropriately.[98]

According to Klopfer people are generally not good at transferring information on their own, noting that some may struggle to apply a pattern in a new context at all. Learning of this sort, he says, isn't worth much. Still, Creating the appropriate conditions for transfer is thus made difficult. If conditions are too complex a player will miss the point. If they are too simple the player will fail to care. Either way the result is poor learning. Games are, in many ways, tailored for the transfer experience. Though transfer occurs more easily in games, the consequences aren't so easily demonstrated.[99] *Re-Mission*, is one example of demonstrated transfer in health-focused serious games.

Re-Mission is one of the most touted health-focused video games of the decade. It is one example of a serious game that successfully balances elements of fun with elements of health learning. *Re-Mission* was designed to help adolescents and young adults living with cancer to increase patient adherence to treatment regimens. Players navigate through bodies, destroying cancer cells and administering medicines. It's a gem among health-focused games because it looks at effort, not just results.

The study took place over the course of three months, during which time more than 300 participants were asked to play games. Researchers asked all participants to play for at least one hour per week, half playing *Re-Mission*, and

the other half playing the commercial PC game *Indiana Jones and the Emperor's Tomb*. (Kato, p. 307) The research team began by examining other studies on how a patient's knowledge about cancer can help improve self-care. They found that increasing knowledge helped increase both treatment adherence and self-efficacy.[100] Their next step was to design a video game that would increase knowledge by engaging patients through play.

In this game, a nanobot called Roxxi would travel through the body, administering various medications and destroying cancer cells. Players would use Roxxi to carry out other parts of the virtual patient's care, too. For example, players would use Roxxi to monitor diet and administer oral care. The more players carried out these positive behaviors, the better the outcomes in the game. Players had to complete each task successfully to progress through the game. It succeeded because the game was designed in such a way that it focused only on the positive outcomes of treatment adherence.

Authors point out that many pre-existing games designed for children with cancer are merely meant to distract patients from pain. This team instead generated a game designed to meet the more challenging task of behavioral change for adolescents and young adults.[101] They believed this type of gameplay intervention would result in increased adherence, and that the increase of positive self-care behaviors would be brought about by changes in knowledge and self-efficacy. "Neither the nanobot nor any of the virtual patients "die" in the game,"

Kato explains. “If players “fail” at any point in the game, then the nanobot powers down and players are given the opportunity to try the mission again."[102]

Although only about 28 percent of all participants fulfilled the 12-hour gameplay recommendation, the test group did demonstrate significantly increased understanding of their cancer. Results were fairly consistent across gender, ethnicity, and nationality.[103] By the end of the study, 16 percent more of test group participants were adhering to antibiotic treatment. They also gave nearly 4 percent more correct responses on the cancer knowledge assessment, and evaluated themselves roughly 0.2 points higher on the self-efficacy evaluation.[104]

Researchers concluded that video games were, indeed, a positive part of health care that could easily be applied to treatment of other chronic illnesses and should be integrated with other health care approaches.[105] They felt that a game with focused in-game behaviors would be a very successful addition to treatment, especially for younger patients.[106]

2.2.4 Play in today’s health-focused serious games

There is a body of research indicating that play is an effective tool in improving a patient’s self care. When trying to change any health behavior Debbe Thompson, a professor and pediatrics specialist at the Baylor College of Medicine, recommends laying out three self-regulating skills: goal setting, goal monitoring, and problem-solving.[107] These, the authors write, increase self-efficacy.

Self-efficacy directly translates into confidence, which in turn translates into behavior change and pursuit of higher goals. "According to self-determination theory, behavior is driven by three basic needs: competence (ability to successfully perform a behavior—influenced by repetition and specific, positively framed feedback), autonomy (having choice and control over behavior), and relatedness (connecting the behavior to important others or personal ideals." Creating an environment that meets these needs successfully increases the likelihood that players will make these necessary changes, and that they will consistently make them in the future.[108]

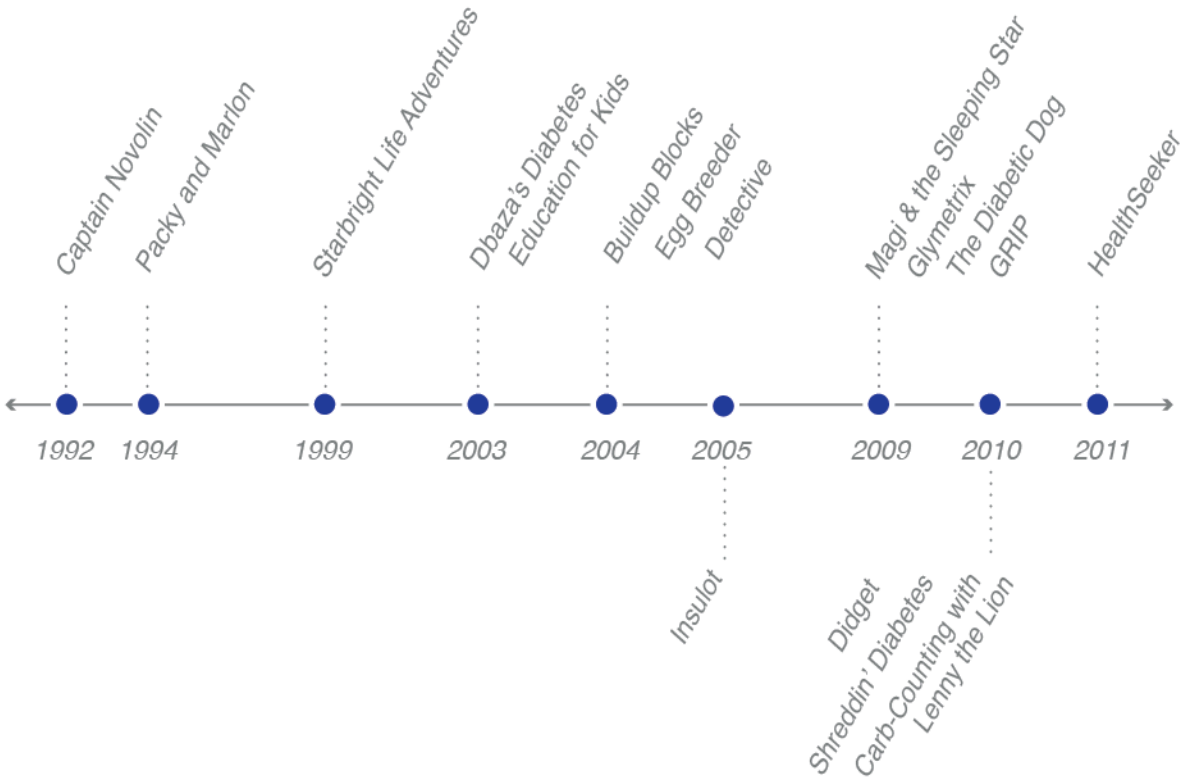
Repetition and frequent feedback can easily be incorporated into both treatment and gaming. Designed properly, players of a health-focused serious game should be able to increase their independence. Thomson further recommends allowing players to observe others performing the same or similar tasks. They should, he explains, be able to learn vicariously through others' attempts and to repeat successful behavior models to increase self-efficacy.[109] "Others" may include caregivers, role models, competitors, or perhaps characters in video games.

In addition to increasing confidence and self-efficacy, games like *Re-Mission* may improve a patient's quality of life by providing joy and developing healthy methods of coping with chronic illness. The types of coping behaviors may be just as important as the behaviors games encourage. Newly diagnosed children are expected to learn self-management at an age when many have yet to master multiplication tables. Learning to manage a chronic health condition is a lot of work, especially for children. Most experts agree that it's critical for a child to develop positive coping mechanisms early on.

The way a patient copes with a chronic illness directly affects his or her quality of life, as well as his or her ability to successfully achieve goals. A person may cope using a regressive or non-adaptive coping strategy, or they may use a mature adaptive coping strategy.[110, 111] The former is often assumed by someone with a fixed mindset personality—it tends to be reactionary, self-defeating, and focuses on failure and other negative outcomes. The latter attitude is more common among growth-minded people. It teaches the individual to accept his or her mistakes, and to focus on ways of bettering his or her health. This attitude would be fostered in an individual with a growth mindset. A growth-minded individual, as we know, will be more likely to experience flow as he or she learns to persevere and modify behavior. Unsurprisingly, the conditions of flow and the growth mindset translate well into healthcare's model for making positive behavioral changes.

Games teach players to adapt through flow and a form of transformational adaptive coping. Transformational coping occurs when, in the face of failure, the individual learns not to dwell on the frustration and instead to redefine the problem, and analyzes his or her options to find a course of action that may allow him or her to solve the problem more easily.[111] The power of gameplay in healthcare has spread quickly. There have been countless health-focused video games released over the past two decades, games designed specifically to help children cope with chronic illness. They range from cute to courageous, urging kids to remain optimistic and to persevere in the face of adversity.

FIGURE 2.2b, Timeline of Diabetes-Focused Videogames



2.3 Usability

Games are incredibly complicated systems. It is no surprise, then, that designing them can be quite tricky. Design usability encompasses all of the stimuli that goes into an experience and uses the perception of these stimuli to evaluate the experience. There are a number of usability considerations that should occur before designing a game. The overall experience can make or break a game, and so these factors cannot be overlooked. Ironically many game designers are not “designers” at all.

Game design teams may include software engineers, animators, psychologists, instructional designers, or even physicists. The team that focuses on aesthetics of the game environment or character animation may need to be knowledgeable of both fine art and kinesiology. They may also need to attend to finer details such as gravity and lighting. Another team will focus on mechanics of the game—how to execute actions and challenges that fit logically with the game’s concept—while still others specialize in the dynamics of the experience, focusing on the emotions and sensory responses gameplay elicits from the user.

The primary goal of this thesis is to pull wisdom from many disciplines to create a more comprehensive model for designing and evaluating health-focused serious games. The first two components—learning and play—are incredibly important, but they are absolutely moot if poor usability prevents players from engaging in the experience. That said there is great debate over which aspects of that experience should drive design.

2.3.1 The great debate over what drives game design

There are a multitude of books doling out tips on game design, but advice differs greatly depending on the expert's background. Thompson, for example, believes narrative should be driving factor in creating the optimal game experience. According to her, the storyline and characters create a system of their own in which the player's perception of objectives are mediated. "Providing choice, connecting goals to personal values, providing immediate performance-related feedback, and structuring the game in levels with challenges that gradually increase in difficulty would enhance competence, self-efficacy, and internal motivation," she further explains.[112] This may be truer for serious games than other types of titles due to their behavior-changing objectives.

Indeed, Thompson writes, narrative enables characters to frame information in a way that captures interest and provides a model of positive behavior. Narrative and characters can also provide players with a sense of progression and goal achievement. Thompson adds that an expert character may be a valuable source of encouragement for less knowledgeable players. In addition to presenting clearer information about the subject, they also present players with obstacles needed to test their problem-solving abilities. Placing a health behavior into this relationship allows players to more quickly observe and assess the consequences. "Enabling the player to make choices for the characters…could help the player see the big picture and develop an understanding of the short- and longer-term effects of these choices on self and others."[113]

Kurt Squire, an expert from the University of Wisconsin-Madison, similarly describes an action-perception method of relaying information to players. Squire is

Director of the Games, Learning & Society Initiative, a project devoted specifically to designing play learning video games. He maintains that by *doing and perceiving* players become one with a game and its actors. Applying learning objectives to the action and perception appropriately, he argues, allows players to learn to adopt these skills vicariously.

A properly designed game experience will encourage both high levels of interactivity and problem solving. It may also, in fact, provide players with a tightly knit network of social support. Multiplayer roleplaying games (RPGs) are one example of how players' interactions within the story and game environment can increase incidental learning and social investment. "The player becomes a hybrid version of himself or herself...players learn not just the facts or procedures (of play) but how to 'be' in the world as the game character, developing the appreciative systems of the avatar as well."[114] This contributes to the flow-inducing immersion that, in turn, facilitates transfer.

In discussing the way players experience transfer between gameplay and the day-to-day, Squire seems to agree with Thompson: the story, characters, and character interactions are all important to a game, and they must be believable to be effective. "They need to immerse players," he writes, "so that they experience the world as (their characters do), replete with perceptions, actions, conversations, and modes of expression where they participate in social practice (as if they were the character)."[115] We need look no further than games like *Everquest* for proof of narrative's power in gameplay and immersion.

It is important to point out that there are effective and immersive games that have been successful channels of learning. Narrative plays no role in video games like *Brick Breaker* or *Pong*, yet these titles have remained popular for more than 40 years. *Tetris* is one of the most successful games ever created, and its independence has allowed it to satisfy players across generations and cultures. Thompson and Squire make a sound argument. Stories are a tool, but perhaps they are not the only or even the most powerful one.

Remember game designer Raph Koster? He asserts that games are *not* stories. Even the ones with narrative qualities, he writes, are more similar to strategic games like chess. The narrative qualities are used to misdirect the player, with the narrative serving as a metaphor for the larger picture. “While metaphors are fun to play with, players can basically ignore them…Since they are about teaching underlying patterns, they train their players to ignore the fiction that wraps the patterns,"[116] Koster explains. “As you get more into a game, you'll most likely cut to the chase and examine the true underpinnings of the game.”[117] Games that *are* narrative-based, he argues, provide insufficient substance to truly expand and improve literary understanding. This is a harsh criticism, but it may be a fair one.

Koster also believes games’ focus on fantasy and power structures may dazzle the player, but do little to improve the learning experience or satisfy genuine needs.[118] Instead, he suggests shifting focus to competition. Competition, he says, is more effective in boosting a player’s sense of mastery, pointing out that some players will

resort to cheating to more quickly experience the thrill of success over letting the story progress naturally.[119]

Still, competition is a form of conflict, something essential to all stories, problem solving, and competition. Perhaps conflict dynamics are a more suitable focal point for game design? In literature there are three types of conflict: man v. man, man v. self, and man v. nature. These types of conflicts may appear frequently in more abstract and metaphorical games with more complex themes; there is almost always some sort of combination of these types of conflict underlying the game.

Take, for example, the game of *Tetris*. *Tetris* may represent informal training in organizing, a skill that could be used when stuffing luggage in the trunk for vacation. For Gee *Tetris* represents something very different. To him, it is a metaphor for courtship. "*Tetris*," he writes, "models one of our deepest human desires: to solve problems by finding patterns inside a safe world in which there is a clear and comforting underlying order.[120] For Gee, *Tetris* represents the conflict between opposing shapes. For someone else it is a conflict of space and time.

In any case, narrative, competition, and conflict—either independently or in unison—create a tension that makes a more exciting game and a more triumphant win. It is when gamers start to make connections between the simplest structures of their games and the similar problems in reality that games become powerful tools for learning and understanding.

2.3.2 Parallels in user and game experiences

Interface design examines the relationship between users, interfaces, and the information that is being transmitted between them. This includes things like the videogame console. It looks closely at user behavior in response to not just the information, but also the way that information is presented. User experience also considers factors of tone, mood, and tension. In gaming, it examines things like players, strategy, and payoff,[121] as well as their behaviors and drives.

Morton Davis, author of *Game Theory: A Nontechnical Introduction*, explains that game theory "considers how one should (and does) make decisions...(it) was designed as a decision-making tool to be used in more complex situations, situations in which chance and your choice are not the only factors operating."[122] He further explains that the difference between problem solving in a real situation and problem solving in a virtual gaming situation is that game environments are not merely manipulated by players.

The environment also manipulates the player.[123] This can be thought of as a series of active affordances, though the relationship between system and player is very different from that between user and interface. Designing a video requires a well-designed interface, *and* a well-designed environment, *and* a well-designed game if it is to be successful. That is why experts like Squire suggest taking a player-centric design approach.

2.3.3 Player-centric design

Player-centric design implies a lot of things. First, it implies a user that will manipulate features of the play environment. Play is a method for learners of all different abilities to acquire and develop skills, so it also implies accommodating differing levels of expertise. Finally, it implies cooperation and communication between the player and the game system. Ernest Adams, founder of the International Game Developers Association, explains that player-centric design "means testing every element and every feature against the standard." If an element of the game does not directly contribute to the player's satisfaction, it should be cut.[124] Fun must the first and foremost measure of good game design. This is true, but it does not take the learning objectives of a serious game into consideration. It gives players what they want, not necessarily what they need. If player-centric design is approached holistically it must do both. Fun must still take center stage, but it must include learning as a playmate.

Recall that the real difference between serious games and commercial games is that serious games are "designed to accomplish a beneficial purpose." Lieberman's earlier point that players will learn as a consequence of play—that games are chosen for their play and not just their learning objectives—suggests that players will be more receptive to, and possibly learn more effectively from, casual serious games than in-office play sessions.[125] Player-centric design can only occur if designers understand the users that will be playing the game. Things like gender and age help designers predict the types of activities a player will perceive as fun, as well as how to anticipate player preferences to engage them in gameplay.

2.3.4.1 Designing for gender

It is a long-held belief that games are more attractive to boys. One reason for this may be that more games are designed for boys than girls. It may also be that more males than females are game designers.[126] While some of the social aspects of learning may differ, learning should not be designed as gendered experiences. Instead, it ought to weigh gender advantages and disadvantages. For example, due to brain and neurochemical structure female players may be better communicators that will respond more favorably to more complex games, while males may respond more favorably to urgency and other physical stimuli. Female players may also take fewer risks and remember more information for longer periods of time.

Male players, on the other hand, may respond more favorably to competition and act more independently.[127] This does not mean that females dislike competition, or that males won't enjoy discovering the key to a more complex game. It simply means that players may be more drawn toward some types of games than others because of how they perceive and process information. Incorporating challenges with opportunities to exercise more diverse thinking makes games more accessible to both sexes.

To explain why girls and boys learn differently, Gurian draws on Gardner's Five Categories of Intelligence. The categories are linguistic, musical, logical-mathematical, spatial and kinesthetic intelligence. Although some differences, including those listed above, occur due to differences in brain structure, the

propensity—and perhaps, then, the effort required—to learn different types of skill may be more affected by nurture than nature.

Gurian points out that many differences in intelligence styles do not emerge until strengths are observed and encouraged. It is natural, he explains, to pursue areas in which we already excel. “One gender's dominance in an intelligence style often grows in part from the other gender's brain hiding its ability to flourish in that style,” he argues. “The concealment is not conscious; it is simply that the brain puts forth into the world what it feels best at, leaving undeveloped (unless the brain is significantly aided) what it does not naturally feel as good at showing the world.”[128]

This instructs different advantages among the genders. Rather than repress certain behaviors in the classroom, Gurian coaxes teachers to strive for balance. "Helping the girls toward physical movement in class along with the boys stimulates their cortical development in spatial intelligence," he writes, "in the same way that calming boys down so everyone can read quietly stimulates their left-hemisphere and linguistic development."[129]

Adams seems to agree with Gurian. Rather than segmenting a game strongly toward one gender or the other, he suggests making games more inclusive by simply removing those strongly gendered components that would *exclude* one gender or the other. So long as the game's design does not offend or bore potential players, it should appeal to both.[130] Like so many other media, it seems the best chance a game has of reaching a diverse group of players is to increasing relevance by offering players an abundance of choices.[131]

The answer may be as simple as offering choices between male or female characters. Indeed, Adams explains, "male players don't actually identify with their avatars as much as female players do. Men are more willing to take the default avatar...(while) Women see an avatar as an extension of their own personalities."[132] For men, he suggests, it's more about the thrill of the experience. Women, on the other hand, may seek games to fulfill a need of expressing themselves.[133] This observation is consistent with Lieberman's and Gee's advice to accommodate players by including more varied games.

This isn't to say there aren't some necessary considerations when designing for the genders. Male and female players may be more sensitive to a game's tone. The fine details in the way one character interacts with others may also be off-putting. The mechanics of an avatar's body language and conduct, for example, can be highly gender-specific. Any discrepancies in behavior, communication, or social interaction may hinder immersion and flow by making it unbelievable or putting the game in the wrong context.

2.3.4.2 Designing for children

Context may be lost on a player without specific prior experience, regardless of gender. Perhaps more important is the matter of age and development. Children and adolescents cannot be expected to experience a game the same way an adult might, or to understand it in the same way for that matter. The younger a player is, the more he or she will need smaller accomplishments along the path to achieving long-term goals.

Adams pushes game designers to aim for focus over panache. "Children don't have as much experience as adults do at filtering out irrelevant details," he points out, "so keep the user interfaces in games for children simple..."[134] Beyond the obvious caution against adult content, motor skills and dexterity should also be considered when designing for children.

Games shouldn't be too easy, but the player must be able to practice what he's learned. As Adams puts it, "it is an error to see children as less skilled, less knowledgeable, mini-adults."[135] Maneuvers requiring difficult key combinations pay present problems to children with small hands and poor dexterity. The level of difficulty a game presents, as well as the type of challenge a player is seeking, should also be considered. The content and player will both demand a different gameplay structure.

Gee discusses horizontal and vertical experiences. Each offers a different, but very important experience for a player. In a vertical learning game, players advance frequently and relatively quickly. Upon achieving a goal, they are presented with another almost immediately. This allows them to learn many skills at varying depths.

Horizontal learning games, on the other hand, are very basic. The sense of urgency is not as high as in vertical games, giving the player more freedom to explore without adding *too* much pressure.[136] Horizontal games may be better suited for "nubes".

2.3.5 Creating the designed experience

Between narrative, competition, age, gender, culture, and learning structure, there are clearly a lot of variables vying for top spot on a game designer's list of guidelines. While they're all undoubtedly important pieces of the puzzle, none would address the whole picture. If a game is to achieve rapport with its players, all aspects must be factored into the equation. We cannot to closely examine one aspect without considering the others. All aspects of a game's design must be evaluated and balanced. Furthermore, it must be able to respond logically to the player. Anything less will degrade the player's perception of the game.

Kurt Squire suggests viewing a game a "designed experience", one that fosters a sense of understanding through carefully balanced rules and goals in both instructional and social spheres.[137] Unfortunately, as Squire points out, too many of the educational or serious games fail to do so successfully. A "designed experience", he postulates, is one in which a player learns a particular ideology through performance, and how players then react to learning in that space.[138] Unlike most other media, games draw players in to make them active agents of the tasks at hand.

Chapter 3. METHODOLOGY + ANALYSIS OF SERIOUS GAMES

Methods of providing healthcare education have become incredibly diverse over the past decade. These tools easily find a place in the lives of adults, but there seems to be a vast area of opportunity to serve newly diagnosed youth. A majority of available resources are still primarily intended for caregivers. This system of secondary care may be acceptable—mom and dad do know best, after all—but there are much more effective methods of reaching kids.

Considering the habits of today's high-tech digital natives, one of the more viable options may be mobile gaming. Games are multifaceted. This is a fact that cannot be disputed. Game research has exploded relatively recently; finding a clear pattern to guide serious game design has been a little like *Pick Up Sticks*.

In theory, if we are to take a truly player-centric design approach to serious gaming, we must include the best features of learning, play, and usability. In considering this, we must ask ourselves: What makes a good game? What role do the instructional and interface designs play in keeping kids engaged and motivated? And finally, how can existing models of evaluation be incorporated and adapted to health-focused serious games?

3.1 Methods + process of evaluation

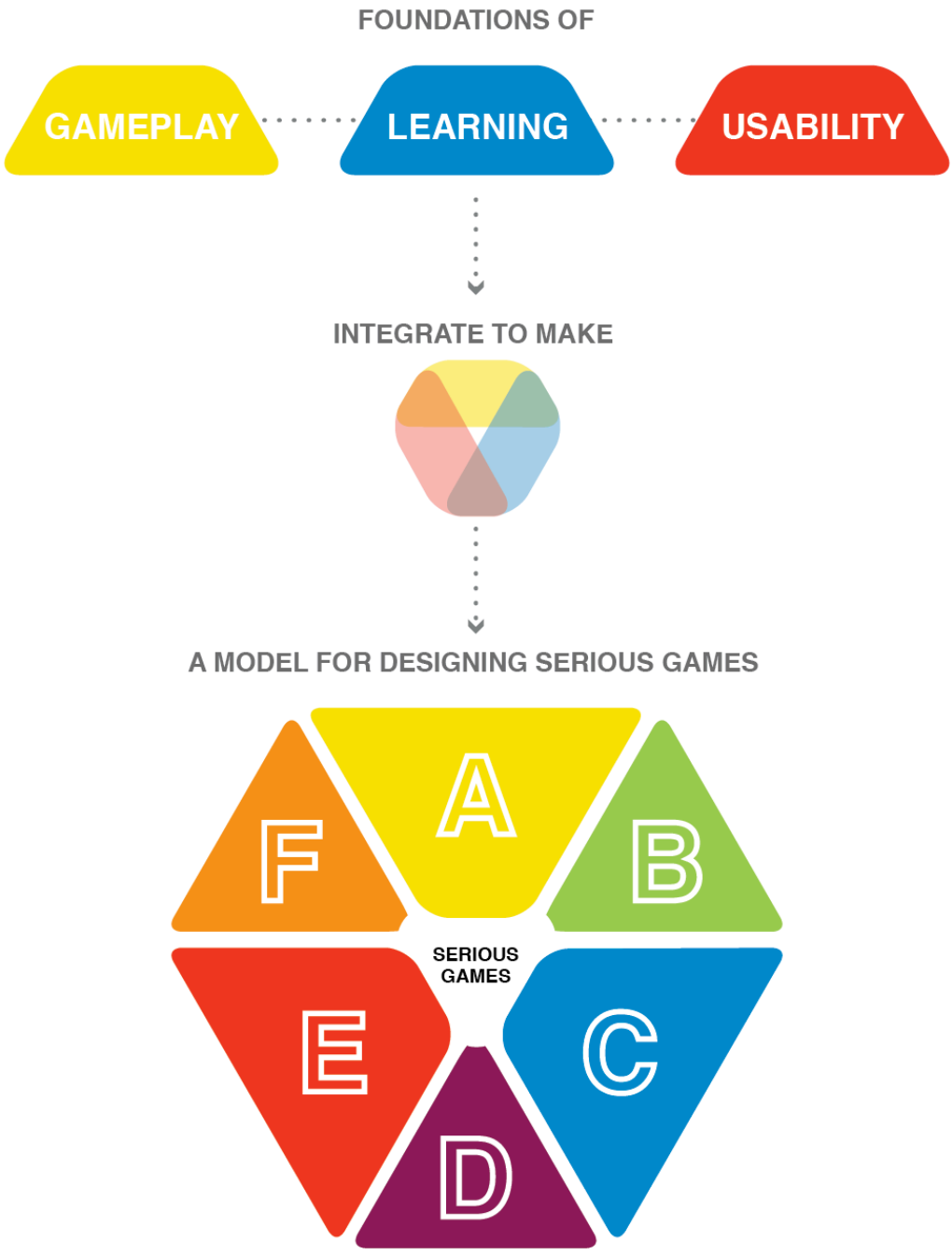
The three categories discussed in the literature review— Gameplay, Usability, and Learning—are similar, but distinct parts of a game experience. Games are a vehicle for discovery that facilitates learning through more engaging experiences. Usability plays a key role in this process as a means for achieving the immersion and flow necessary to transfer. Learning, by its very definition, is the acquisition of knowledge of skills through experience and study.[139]

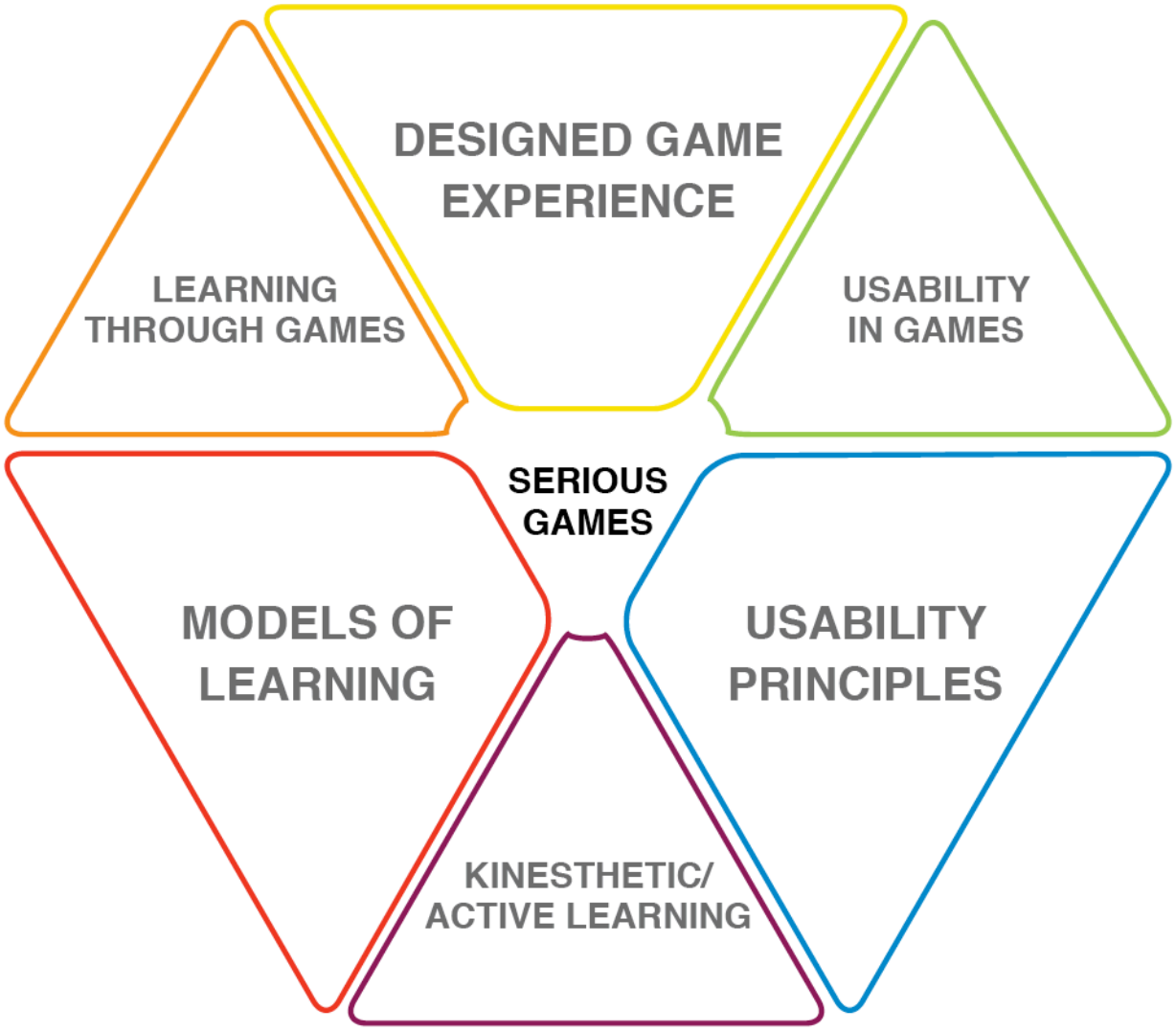
Transfer occurs when what is learned in one context can be applied in another. Research detailed in this thesis indicates that a serious game has greater chance of succeeding in its objectives if the three are carefully integrated. The categories of Games, Usability, and Learning are weighted equally to outline principles for creating an optimal serious game experience. A diagram describing this trifecta and the areas in which they coalesce follows.

To establish a model of evaluation for health-focused serious games, twelve existing models were selected, analyzed and synthesized. These models included principles of traditional education, health education, learning, interface usability, game usability, gameplay, and game experience. The items in each of these 12 models were summarized in Steps 1 and 2, and then assigned a primary and secondary value in Step 3. Items were then categorized in Step 4, before being integrated in the final model laid out in Step 5. Step 5 also includes an evaluation of five games using this proposed

model to indicate how game designers might use it to shape and assess their work. A more detailed description of each of these steps is included in section 3.2.

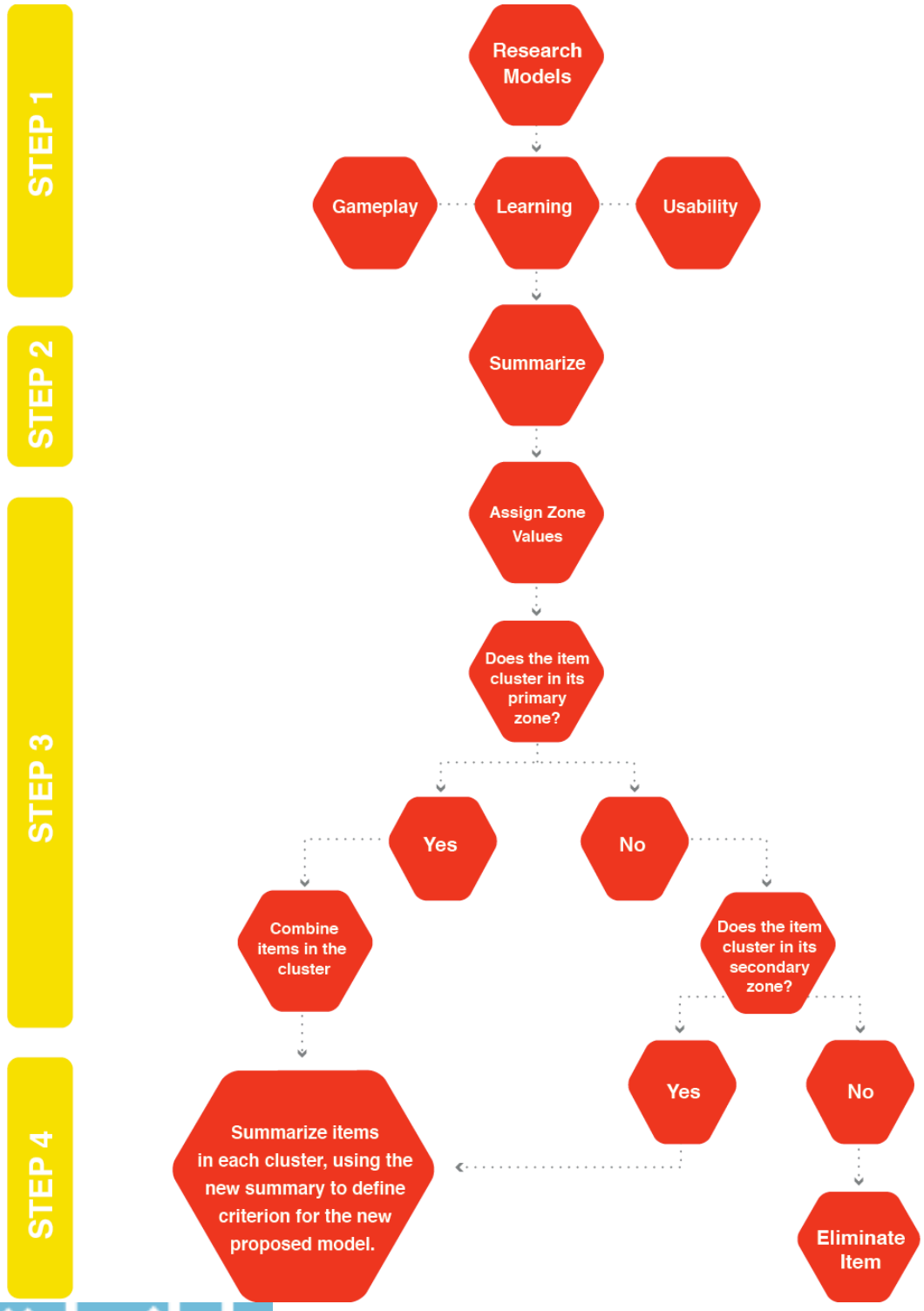
FIGURE 3.1 Understanding the Diagram and Its Zones





3.2 Methodology overview

FIGURE 3.2, Criteria Selection Process



STEPS 1 + 2

Twelve existing gaming, learning, and usability models were chosen for analysis and detailed in a table. Each model item was assigned a number.

FIGURE 3.3, How to Read the Tables

Item #	Description	Primary	Secondary
0.0	A brief description of each item with notes and	(A)	(B)

STEP 3

Items were then assigned a primary zone, and a secondary zone. Items were first sorted into clusters of similar items based on their primary zones. Non-duplicate items that did not fit with other items in one of the primary clusters were re-categorized and mapped into their secondary zone clusters. Items that were eliminated after secondary zone categorization were eliminated completely.

STEP 4

Clustered criteria were synthesized and defined in new items in the new model for health-focused serious games. To create a more balanced, more comprehensive method of evaluating health-focused serious games, the final evaluation model was composed devoting three criteria to each of the three major zones (A, C, E) and two additional to the minor zones (B, D, F).

STEP 5

The resulting set of criteria, shown on page 107, was finalized and applied to five games—one commercial game (*Skylanders: Giants*), one health-focused serious game with demonstrated success (*Re-Mission*), and three health-focused games targeted to kids living with diabetes (*Carb Counting with Lenny the Lion*, *Shreddin' Diabetes*, and *The Diabetic Dog*). The first of the health-focused games was an educational game, the second an edutainment game, and the third a health-focused serious game. The results of these evaluations demonstrate the model's effectiveness.

Chapter 4. MODEL EVALUATION + MEASURES

4.1 STEPS 1 + 2: EXISTING MODELS OF EVALUATION AND CATEGORIZATION

Model #1: Mechanics, Dynamics, Aesthetics (MDA)

A team of game developers and researchers from MIT and Northwestern University developed the MDA model to help game design teams develop more cohesive games. This system was formulated to help guide their production. Design and videogame consumption, according to lead author Robin Hunicke, each have three correlated components. From a player's perspective, games are about the rules, the system, and the entertainment. In design, this becomes mechanics, dynamics, and aesthetics, respectively.[140] "MDA supports a formal, iterative approach to design and tuning," Hunicke writes. "By understanding how formal decisions about gameplay impact the end user experience, we are able to better decompose that experience, and use it to fuel new designs, research and criticism respectively."[141]

TABLE 4.1, The MDA Model: Mechanics, Dynamics, and Aesthetics

Item #	Description
1.01	**MECHANICS** refer to the pieces of the game that project information and patterns; they inform dynamics.
1.02	**DYNAMICS** refer to game's response to the player's efforts and achievements during play.
1.03	**AESTHETICS** are the emotional response a game elicits from a player. Aesthetics account for the game's ability to entertain and engage a player. Aesthetics include things like expression, discovery, sensation, challenge, and narrative.[142] All of these aesthetics can be channels of action and feedback for players, channels that are essential in designing a successful game.

"These models help us describe gameplay dynamics and mechanics...If the player doesn't see a clear winning condition, or feels like they can't possibly win, the game is suddenly a lot less interesting."[143]

The concept is actually quite simple on the surface. In a competitive racing game in which players earn points for sequence *and* targets hit, both the clock and the targets act as dynamics. The timer pushes players to move quickly to pass other players through a competitive, dynamic tension. Targets urge players to master their driving skills, pushing them toward mastery. Crossing the finish line acts as a mechanic, signaling to the player that he or she has completed the race. A secret route may achieve the same result for players toward the back of the pack, as it encourages them to continue trying. This is reinforced by the aesthetics of discovery, sensation, and challenge.[144] Evaluating mechanics, dynamics, and aesthetics at each phase of the game development process ensures that the most important aspects of the experience will not become lost along the way.

Model #2: Calleja's Six Dimensions of Involvement

Gordon Calleja is a professor and Head of the Center for Computer Games Research at the IT University of Copenhagen. Calleja's research closely examines immersion in gameplay, something we know aids in transfer and learning. In order for the player to immerse himself in a game, he must perceive himself as if his presence truly was in the game. Immersion seems to be a phenomenon of flow in gaming, but Calleja thinks it may be a natural response of player involvement. This "player involvement model" points to six different dimensions of involvement, arguing that these are what build a player's sense of presence.[145]

TABLE 4.2, The Six Dimensions of Involvement

Item #	Description
2.01	**KINESTHETIC INVOLVEMENT** is the ability to manipulate actors and environment within the game, and to take action that will result in a particular set of consequences; also referred to as agency.[146]
2.02	**SPATIAL INVOLVEMENT**, in videogames, is the ability to perceive, explore and discover freely in a virtual environment[147]
2.03	**SHARED INVOLVEMENT** refers to the player's ability to interact with other players or automated components
2.04	**NARRATIVE INVOLVEMENT** is the ability of a player to affect a game's narrative through a series of actions, and the ability to experience a unique story through feedback[148]
2.05	**AFFECTIVE INVOLVEMENT** is the ability to engage a player emotionally through a series of feedback between player and game system; the ability of a player to "customize" their experience through choices, and the system's ability to bring about certain outcomes through (action-specific) feedback[149]
2.06	**LUDIC INVOLVEMENT** is a player's ability to select, set, and achieve goals through playful or willfully chosen means. Ludic involvement leads to self-competency and mastery.[150]

By providing sensory information to the child's brain through the game, they help him become more in tune with the gaming environment, not to mention helping them learn to focus and sort out unnecessary details. Immersion can only go so far, though. If flow is to remain uninterrupted, then a game must also exhibit good usability heuristics.

Model #3: The Nielsen Norman Group's 10 Usability Heuristics

Heuristics are what allow learners to figure things out on their own through exploration.[151] Jakob Nielsen compiled this list with Rolf Molich in the early 1990s. They developed a set of criteria after conducting several studies on usability, before testing them on nearly 250 different "problems".[152] Testing allowed them to further refine their criterion, resulting in the list below.

TABLE 4.3, Ten Usability Heuristics

Item #	Description
3.01	Visibility of system status
3.02	Match between system and the real world
3.03	User control and freedom
3.04	Consistency and standards
3.05	Error prevention
3.06	Recognition rather than recall
3.07	Flexibility and efficiency of use
3.08	Aesthetic and minimalist design
3.09	Help users recognize, diagnose, and recover from errors through affordances, and feedback—both activational and behavioral. activational feedback - lets the user know an input was executed and received behavioral feedback – demonstrates the effects of a user's actions on the system; if an action was successful, he or she moves on. If not, he or she makes another attempt
3.10	Help and documentation

The versatility and reliability of these principles in improving design account for their success. The process of their inception has influenced my process for creating a model of design principles for health-focused serious games. Nielsen's list is still widely used to evaluate user interfaces. Even now, his partner, renowned designer Donald Norman, continues to present on these and other principles of good design.[153]

Model #4: The Interpretation Construction Design Model (ICON)

John Black and Robert McClintock of Columbia University developed the ICON Model to guide what they call study support environments (SSEs). They felt that the process of studying is a more important aspect of learning than the way the knowledge is administered.[154] Construction philosophy states that knowledge is constructed as a result of observation and experiences. Learning through games works in this same way. A successful game will enable transfer of knowledge and behaviors by creating a positive SSE within a game.

TABLE 4.4, Interpretation Construction Model (ICON)

Item #	Description
4.01	**WATCH + LEARN** by studying a problem in its natural context.
4.02	**PERCEPTION ANALYSIS** allows learners to really assess and make sense of information, giving them a chance to reason and form deeper meaning.
4.03	**CONTEXT IS KEY** to understanding; background research forms a more concrete understanding of a subject.
4.04	**A STUDENT-TEACHER relationship** in which learners observe and assist experts to increase their mastery of a subject.
4.05	**TEAMWORK** in small groups helps learners better analyze and construct understanding of a subject. This exposes them to many perspectives.
4.06	**MANY PERSPECTIVES** allow students to expand their understanding, or to work toward mastery through a horizontal learning experience.
4.07	**MANY APPLICATIONS** of the same knowledge by others will further enhance a learner's understanding of a subject.

The ICON Model was developed in the mid 1990s in response to an increasingly digitized classroom. Under the ICON Model, learners are able to discover things on their own and with the help of others. We see this in several of the items. Item 4.04 evokes Vygotsky's zones of proximal development in which learners increase knowledge and skill by teaching less experienced students and learning from more advanced ones. We also see this successfully implemented in flipped learning classrooms, or via think-pair-share activities.

This apprenticeship is also apparent in games like *World of Warcraft* in which players of many skill levels can complete challenges or go on raids together. The true strength of the ICON Model lies in its balance of social and individual learning. Applied in experiential activities, it shows promise in helping learners modify behavior.

Model #5: Gee's 25 Principles of Learning and Gaming[155]

James Paul Gee writes that good games are designed to engage players who have already, in some ways, prepared themselves through gameplay for the new game experience. They seek new game challenges because they have already mastered others, and are ready to take on another new challenge. In facing this challenge, they assume that they will have to put in time and effort to achieve mastery.[156]

TABLE 4.5, 25 Principles of Learning and Gaming

Item #	Description
5.01	A good game motivates players to play for extended periods of time
5.02	Presents and encourages "preparation for future learning" through practice
5.03	Presents opportunities for horizontal *and* vertical learning experiences
5.04	Creates a low-stakes game environment
5.05	Encourage learners to self-evaluate and self-direct
5.06	Offers players options
5.07	Does not "coddle" players
5.08	Does not require players to know more than the basics before play begins
5.09	Creates opportunities for players with different levels of expertise—even "nubes" can be experts in some things
5.10	Provides basic instruction in increasingly difficult levels to help the player practice and understand the game
5.11	Teaches skill sets, and demonstrates how and why they are to be learned
5.12	Urges players to observe skills in solving simple problems in the form of demos
5.13	Allows them to test new skills on gradually more complex problems (practice)
5.14	Presents and repeats information in many formats so that it will be understood and retained by players of many learning styles
5.15	Allows information to "trickle" to create a sense of urgency
5.16	Fosters relationships and a sense of communication between game system and players through input and feedback

5.17	Gives players room to customize their experiences and make mistakes
5.18	Teaches players about the game's genre and how it works early in the game
5.19	Seamlessly integrates demos and actual gameplay, creating fluid transitions
5.20	Merges learning and play
5.21	Pushes players to push themselves and their limits to achieve potential
5.22	Presents players with constant challenges to apply what they've learned while also learning new things
5.23	Allows players to learn and play at their own pace, making it okay to fail and re-attempt
5.24	Provides players with a wide range of resources to learn about the game
5.25	Includes a diverse group of players who may interact and learn from each other

Designed correctly, Gee argues, a game has the power to immerse students in active, highly experiential roles for learning. Players of a game also have the power to move at their own pace, allowing them to decide whether or not they have mastered a skill enough to move on. Players are given choices, and so this gives them greater control of the experience and the communication loop.

When a good game reaches the right sort of players, it will engage them in a way that makes them "feel that their minds and bodies have been extended...This process appears to allow players to identify powerfully with the virtual character or characters they are playing in a game and to become strongly motivated to commit themselves to the virtual world the game is creating with their help."[157] Gee's observation suggests that a properly designed system would be incredibly effective in shaping player behavior.

Model #6: VandenBerghe's Five Domains of Play[158]

Jason VandenBerghe is Creative Director at Ubisoft, a company best know for games such as *Assassin's Creed* and *Red Steel 2*. Unlike Calleja, VandenBerghe conducted a more in-depth examination on the role of personality in experience. He translates five dimensions of a player's personality (openness to new experiences, conscientiousness, extraversion, agreeableness, and neuroticism) into motivating game experience qualities (novelty, challenge, stimulation, harmony, and threat).[159]

TABLE 4.6, The Five Domains of Play

Item #	Description
6.01	**NOVELTY** refers to a player's preference for familiarity in components of and challenges presented by a game; their desire for expected or unexpected events, continuity, sameness
6.02	**CHALLENGE** is the "desire for...effort and control—with the trait of conscientiousness," often correlated with players' difficulty level preferences
6.03	**STIMULATION** indicates the degree of social interaction a player desires with other people, either for competition or collaboration
6.04	**HARMONY** is the level of cooperation required by a game. Do players prefer to work together or compete?
6.05	**THREAT** indicates the way players respond to unpleasant emotions created by the game such as fear, tension, or danger

The "Five Factors" look at game design through a user-centric lens, something more commonly used in UIX and interaction design. Though they provide greater insight into player motivation, they do share characteristics of Hunicke's *Mechanics, Dynamics, and Aesthetics* model. While both examine experiential factors, VandenBerghe's provide glimpse into the social dynamics of gaming.

Model #7: McGonigal's 4 Defining Traits of a Game + 7 Reality Fixes

Jane McGonigal's work as Director of Games Research at the Institute for the Future has contributed some of the most successful serious games of the last decade. From her extensive game research, she has developed her own list of traits defining a good game. Her list is based largely on Csikszentmihalyi's rules for flow, however hers is specific to gaming. As there is often difficulty differentiating edutainment games, commercial games, and serious games, this is an appropriate model to examine. McGonigal further created a list of fourteen reality "fixes", Items 7.5-7.11 below, based on key aspects of good games.[160]

TABLE 4.7, The Four Defining Traits of a Game, and the Seven Reality Fixes

Item #	Description
7.01	Games have clearly defined goals, giving players a "sense of purpose"
7.02	Games exhibit rules and limitations to "unleash creativity and foster strategic thinking"
7.03	A rapid feedback system keeps players motivated and indicates progress toward achieving the goal.
7.04	Acceptance of the rules and goals, as well as a level playing field for multiplayer games. McGonigal calls this voluntary participation—it indicates a player's "freedom to enter or leave a game at will."[161]
7.05	Games provide challenges and "unnecessary obstacles" that allow players to exercise their strengths. These obstacles are consciously chosen.
7.06	Games facilitate flow, causing players to focus their energy in a positive way.[162]
7.07	Games are clearer and more engaging, making the work more satisfying for players.[163]
7.08	The low-stakes environment of games reduces player anxiety and fear of failure.[164]
7.09	High engagement in games helps players build relationships and creates a sense of community.[165]
7.10	Collectivity and shared goals give game actions and achievements great value.[166]

7.11	Games provide greater motivation, and more wholly incite player investment.[167]
7.12	Games reward effort more than achievement, encouraging internal motivation.[168]
7.13	Game structure encourages forming positive communities with shared goals, and is more inclusive.[169]
7.14	Games are "happiness hacks", allowing players to use something they already enjoy to learn new patterns and solve new problems.[170]
7.16	Games inspire players to achieve larger than life feats, or "epic wins".[171]
7.17	Games are well organized and broken into many small tasks that can be completed by many players collaborating as a tightly knit team.[172]
7.18	Games encourage players to focus on the future, allowing players to envision and shape one without limits.[173]

McGonigal argues that people are compelled to play games because reality is unsatisfactory. These fixes are essentially her suggestions of how to incorporate some of the pleasure games provide into daily activity. This is especially important to consider in regard to health-focused serious games designed specifically to transform behavior.

Model #8: Thompson's 5 Rules for Video Games

Debbe Thompson is a doctor, professor, and pediatric specialist at the Baylor College of Medicine, where she spends much of her time researching digital media and behavioral nutrition. Thompson's rules are a five-factor model of design intended specifically for serious games. They are derived from cognitive and social cognitive theory, and incorporate many aspects of both constructivist and behavioral learning theories. Thompson's research is interesting in that it specifically examines health-focused serious games for self-management. She cites several intended for individuals living with Type 2 diabetes. It is important to include Thompson's rules because the proposed model will be tested on serious games exhibiting very similar qualities, subjects, and desired health behaviors.[174]

TABLE 4.8, 5 Rules for Video Games[175]

Item #	Description
8.01	Knowledge and skill must both be attained to facilitate behavior change.
8.02	Players may better achieve mastery through use of avatars in gameplay.
8.03	Games that provide characters exhibiting positive behavior provide a better model for players to observe and emulate.
8.04	Tailored games allow players to become more invested in achieving difficult tasks; this sparks flow.
8.05	Fun comes first; a game must entertain to engage.

Some of Thompson's items—specifically item 8.02—become especially powerful because of repetition and immersion, things we know are essential to both formal and play learning. Modeling encourages players to achieve mastery by performing a task the

right way, while tailoring it to the player's needs and wants helps establish rapport between the player and the game. It communicates to the player why they should become invested in the game, and how playing will help them achieve their goals.[176] It creates a hook, which motivates them to engage in extended gameplay. This repeated exposure could help players internalize the serious skills they're supposed to glean from the game in an entertaining and exciting way. Fundamentals *are* the foundation of fun, after all.

Model #9: Shneiderman's Eight Golden Rules

Ben Shneiderman is a professor at the University of Maryland's Human-Computer Interaction Lab, where he has researched and established one of the foremost canons in interface and usability design. He compiled the following list of rules with his colleague Catherine Plaisant to guide the design of interactive systems. Though it is primarily intended for web interface design, it also applies to user experience. This list was designed to be flexible. As a result, many of the rules can easily be applied to the design of games and their systems, as well as instructional design.

TABLE 4.9, Shneiderman's Eight Golden Rules [177]

Item #	Description
9.01	**BE CONSISTENT** in layout, prompts, language, and action sequences. Anomalies should be kept to a minimum to prevent confusion.
9.02	**BE INCLUSIVE** to accommodate users with different expertise, cultural heritage, and ability. Shneiderman calls this designing for *plasticity*.
9.03	**GIVE FREQUENT, TIMELY FEEDBACK** that indicates importance as well as accuracy. Feedback may be delivered visually, acoustically, spatially, haptically, and/or cognitively.
9.04	**GIVE USERS CLEAR CONFIRMATION** when a task is completed successfully. This reassures and pleases the user while increasing trust in the system.
9.05	**REDUCE ERRORS** by designing a system that allows the user to make fewer errors and recover independently.
9.06	**ALLOW USERS TO STEP BACK** by designing a system in which users can return to a previous step or "undo" an action. This reduces fear of failure.
9.07	**THE USER IS IN CHARGE**, so a system must respond to the user. A weak communication loop, or monotonous or redundant tasks degrades the experience.

9.08 **BE INTUITIVE** in a design to lessen some of the user's burden. Psychological chunking and simplifying tasks reduces cognitive and short-term memory load.

Note that the principles are similar to those in Nielsen's list of usability heuristics. In fact, several of the rules seem to reiterate aspects of other models. For example, Item 9.02 is relatively consistent with Gee's recommendations to map both horizontal and vertical learning experiences to include a variety of games, and to make games inclusive to users despite gender, culture, or experience. Interpreted more loosely, it may include creating multiplatform games as well.

Overall, the flexibility of this model is an asset. On one hand, Items 9.07 and 9.05 may be ill advised, as gamers choose games *because* they are difficult and some failed attempts increase the reward when mastery is achieved. On the other hand, a growth mindset means a player must be able to re-attempt a challenge. Games *should* give a player a sense of competency and allow him control over the experience by customizing difficulty levels and goal setting. The latter becomes an area of great importance in health-focused serious games intended to improve self-care.

Model #10: The AADE's 7 Self-Care Behaviors

The American Association of Diabetes Educators[178] created a list of seven self-care behaviors, several of which were mentioned previously, to help people living with diabetes learn to manage and cope with the disease. Their objective in creating this list was to help patients adapt to a new lifestyle and to assume more positive health behaviors. As behavioral change is also the objective of serious gaming (especially those that focus on health topics).

Serious games are specifically created as tools for behavioral change, so it was more than appropriate to include analysis of the "AADE 7" in the proposed model. In addition to the AADE's 7 Self-Care Behaviors, another item (10.08) was added to reflect recommendations from the International Society for Pediatric and Adolescent Diabetes (ISPAD) for regular re-education.[179]

TABLE 4.10, The AADE's 7 Self-Care Behaviors

Item #	Description
10.01	**DIET** Make positive dietary choices, understand nutritional values, or how certain foods may affect the body.
10.02	**EXERCISE** Increase activity, explore the relationship between food, insulin, and exercise, or learn about the importance of weight control.
10.03	**MONITOR** organ function, glucose levels, weight, and other medical metrics; learn to decipher these figures.
10.04	**MEDICATE** learn about the effects, roles, and function of different medicines, as well as how to administer and adjust them.
10.05	**PROBLEM SOLVING** can help PWDs learn to take care of themselves or seek help in the event of an emergency, as well as how to manage their disease more independently. This may also include establishing coping mechanisms.

10.06	**SAFETY** how to reduce long-term health risks of diabetes, as well as how to recognize and respond to side effects of diabetes or diabetes treatment.
10.07	**COPING** strategies help PWDs stay healthy and positive. Social networks, motivation, and attitude are key to healthy coping behavior.
10.08	**LEARN** improve comprehension and mastery through regular review and exposure to new information. In gaming this may be accomplished through *infinite games*.

With the exception of Item 10.08, all items are specific behaviors moving toward of health behavioral change. For this reason, it may not be appropriate for all of them to be contained within a single game.

A better approach may be to look for games focusing on at least one of these behaviors, or ones that break multiple behavioral aspects into “chunks” and map these pieces into the game. Game designers may do so through game levels or special challenges within a game or else the game system structure. For example, an active Wii game might help a player improve fitness while learning about its effects on diabetes management.

MODEL #11: Squire's Principles of Player-Centric Design

Kurt Squire, co-founder and Director of the Games, Learning, & Society Initiative at the University of Wisconsin Madison, pushes designers toward player-centric design. Player-centric design means creating games that help a player learn by *doing*. Squire's recommendations for player-centric design essentially tell us the most successful game experiences connect to all aspects of a player's experience by engaging their mind (knowledge and problem solving), their bodies (action and task completion), and spirit (flow and fun). The following list provides ten tips on how to appeal to a player on a deeper level.

TABLE 4.11, Principles of Player-Centric Design

Item #	Description
11.01	**SHOW EMPATHY** by considering what genuine needs and desires a game fulfills to the user, as well as how those needs should be mapped into the game.[180]
11.02	**SET THE STAGE** A virtual world often becomes real to its players, and so the environment and experience must be designed as such. It must be believable with its own set of mores. This includes explicit game rules and implicit cultural ones.
11.03	**ROLEPLAY RULES** gaming. Players can test and assume different identities for both their avatars and themselves while learning the game's core values.
11.04	**THE PLAYER IS THE HERO**, not the designer. The process of the experience, not the content, should drive a game's design.
11.05	**PLAYERS NEED TO BE FREE** to explore and learn through performing specific tasks better than any other method. They're literally and figuratively going through the motions—"actions are (the) interface."[181]
11.06	**CONSTRUCT LEARNING ENVIRONMENTS** through social interaction and/or different problem solving scenarios.

11.07	**GAMES SPEAK IN IMAGES**, so graphics are an important form of communication. In some ways, Squire writes, they become another gaming language necessary for players to thrive in a game.
11.08	**SHOW THE PLAYER IS WHAT IMPORTANT** by eliminating unnecessary or conflicting information.[182] Squire writes that this is one way to map a level of learning ideology into the game.
11.09	**GIVE THEM JUST ENOUGH** information to keep them interested and to allow them to play the game well. This creates urgency, while also allowing players to process information in smaller, more manageable chunks.[183]
11.10	**A GAME IS WHAT A PLAYER MAKES IT**—players have lots of options, lots of paths they can take, and thus many ways of perceiving and constructing meaning from those experiences. This is a good thing.

Squire's point in Item 11.10 essentially details Klopfer's explanation of transfer. . Squire also argues that games should be put in relatively realistic contexts. He additionally suggests that in the right context games can become cultural artifacts, demonstrating appropriate behavior and interactions. This allows players to move from understanding to embodying what they've learned. Squire describes these as "situated experiences". The truer to life an experience is, the greater likelihood transfer will occur.

His other point to grant players agency (Item 11.5) is just another form of customization. Games require designers to design for *all possible choices* a player might make, unlike usability design, which uses affordances and other cues to subconsciously direct users. This freedom poses a challenge to designers because it can sometimes make harnessing gameplay's potential difficult. Several learners may glean very different messages from the same game—the *Tetris* analysis Gee gave previously is a good example. What players perceive is determined partially by what

they already know, and partially how they make sense of the new information and ideas presented in a game.

As Squire puts it, designed experiences occur at "the intersection of design constraints and players' intentions."[184] Game designers can make some ideas more easily decipherable to help a player along, but if quality learning is to occur, then the rest must be left up to the player. That is perhaps the most significant difference between edutainment and serious games.

Model #12: Reese's Principles of GaME Design

The final model is Reese's four principles of GaME design. Debbie Reese is an educational researcher at Wheeling Jesuit University's Center for Educational Technologies. GaME, in this model, stands for "game-based, metaphor-enhanced". Reese developed this model to promote transfer through the use of metaphor. Its purpose is to help game designers make better analogies between games and to guide designers toward more intuitive games that better connect game concepts to their lessons. These are the conditions of transfer, something essential to serious games.

"GaME design enhances control over the alignment among three systems: the analog's domain structure, the target domain's relational structure, and the mental model constructed by the learner," Reese writes. "…players experience episodes of game play that provide direct experience analogous to targeted learning."[185]

The optimal learning zone is where game patterns and learning patterns overlap with a learner's pre-existing knowledge.[3, 185] Reese's principles show how to address some of the problems presented by Squire's Items 11.05 and 11.10, especially regarding transfer and believability.

TABLE 4.12, GaME Design

Item #	Description
12.01	Create a relationship between the game's pattern and a desired, unknown pattern in reality. The concepts being mapped must share a similar domain.
12.02	**REALISTIC GOALS + LIMITATIONS** Make sure that the game environment will spur players to form the right goals, and present them with realistic challenges and limitations in their pursuit. This will provide motivation and more meaningful work.

12.03	**FACILITATE FLOW** by giving players balanced challenges and achievements, all supported with adequate feedback. Give them a sense of purpose by making sure challenges are not too easy or too frivolous.
12.04	**GIVE PLAYERS TIME**, not just to build skill and achieve their goals, but also to reflect on their mistakes, their achievements, and their learning experience.

Reese notes that the fourth and final principle is the most valuable in converting to long-term knowledge, and that it cannot be achieved when the other three principles are not effective. Just as designers map values into games, learners map information into the mind, converting important concepts into long-term memory through experience and repeated exposure. Repeating these relational/analogous experiences in the game helps the player construct knowledge and transfer meaning from one pattern to the other. This is essentially what Klopfer and Calleja describe when they discuss facilitating transfer through player involvement.

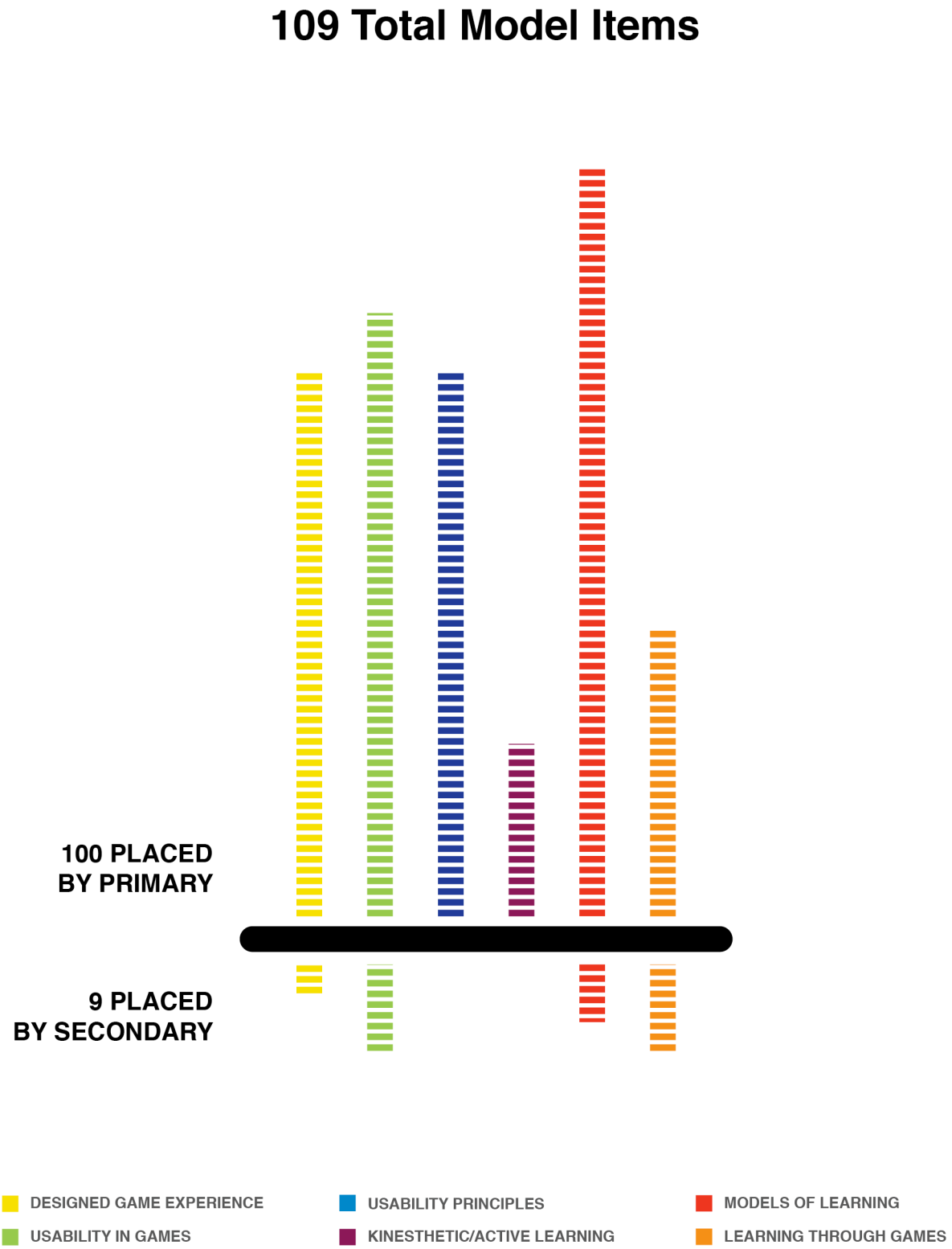
"A good novel or movie focuses on experience salient to its story and compresses days, years, and even lifetimes in a few hours," Reese writes. "GaMEs focus on experience relevant to the targeted conceptual domain. Over a few hours of engineered game play, players experience days, years, and even lifetime equivalents of viable transactions with the target domain."[186]

4.2 Step 3: Organizing data

4.2.1 Distribution of Model Items in Primary and Secondary Zones

Items were sorted into the different zones of the diagram. Items that were not duplicated but not eliminated in the primary column were mapped into their secondary section. After each model item was mapped into the diagram, each section was re-examined; similar items were combined. Items that were eliminated after secondary placement were then eliminated altogether.

FIGURE 4.2a, Zone Distribution



4.2.2 Categorization summary

Items were sorted based first on their primary zones. Duplicate items, or items that had more in common with items in the other zones were then categorized by their secondary zones.

FIGURE 4.2b, Final Item Assignments

A		B		C		D		E		F	
Prim	Sec	Prim	Sec	Prim	Sec	Prim	Sec	Prim	Sec	Prim	Sec
1.03	11.05	1.02	2.03	1.01		3.06		4.01	8.02	5.08	5.04
2.01		2.02	6.04	2.06		3.09		4.02	8.03	5.09	7.12
2.04		4.05	6.05	3.01		3.02		4.03		5.10	7.14
2.05		5.15		3.04		5.18		4.04		5.13	
3.03		5.16		3.05		5.24		4.06		5.02	
5.01		5.25		3.07		11.03		4.07		5.20	
5.02		6.03		3.08				5.03		5.23	
5.07		7.04		3.10				5.05		8.01	
6.02		7.06		5.06				5.11		11.10	
7.01		7.09		5.17				5.12		12.01	
7.02		7.11		5.19				5.14			
7.05		7.13		7.03				5.21			
7.08		7.17		7.07				5.22			
7.10		9.02		8.04				7.16			
7.18		9.03		9.01				9.06			
8.05		11.07		9.04				9.08			
11.01		11.08		9.05				10.01			
11.40		11.09		9.07				10.02			
12.02		12.03		11.02				10.03			
								10.04			
								10.05			
								10.06			
								10.07			
								10.08			
								11.06			
								12.04			

4.2.3 Synthesis into clusters

ZONE A

Item #	Description	Primary	Secondary
1.03	**AESTHETICS** are the emotional response a game elicits from a player. Aesthetics account for the game's ability to entertain and engage a player. Aesthetics include things like expression, discovery, sensation, challenge, and narrative. All of these aesthetics can be channels of action and feedback for players, channels that are essential in designing a successful game.	**A**	C
2.01	**KINESTHETIC INVOLVEMENT** is the ability to manipulate actors and environment within the game, and to take action that will result in a particular set of consequences; also referred to as agency.	**A**	F
2.04	**NARRATIVE INVOLVEMENT** is the ability of a player to affect a game's narrative through a series of actions, and the ability to experience a unique story through feedback.	**A**	B
2.05	**AFFECTIVE INVOLVEMENT** is the ability to engage a player emotionally through a series of feedback between player and game system; the ability of a player to "customize" their experience through choices, and the system's ability to bring about certain outcomes through (action-specific) feedback	**A**	B
3.03	User control and freedom	**A**	C
5.01	A good game motivates players to play for extended periods of time;	**A**	B
5.07	Does not "coddle" players;	**A**	B
6.02	**CHALLENGE** is the "desire for...effort and control—with the trait of conscientiousness," often correlated with players' difficulty level preferences	**A**	C
7.01	Games have clearly defined goals, giving players a “sense of purpose”.	**A**	B
7.02	Games exhibit rules and limitations to “unleash creativity and foster strategic thinking.”	**A**	B
7.05	Games provide challenges and “unnecessary obstacles” that allow players to exercise their strengths. These obstacles are consciously chosen.	**A**	B
7.08	The low-stakes environment of games reduces player anxiety and fear of failure.	**A**	F

7.10	Collectivity and shared goals give game actions and achievements great value.	**A**	**B**
7.18	Games encourage players to focus on the future, allowing players to envision and shape one without limits.	**A**	**F**
8.05	Fun comes first; a game must entertain to engage.	**A**	**F**
11.01	**SHOW EMPATHY** by considering what genuine needs and desires a game fulfills to the user, as well as how those needs should be mapped into the game.	**A**	**B**
11.04	**THE PLAYER IS THE HERO**, not the designer. The process of the experience, not the content, should drive a game's design.	**A**	**C**
12.02	**REALISTIC GOALS + LIMITATIONS** Make sure that the game environment will spur players to form the right goals, and present them with realistic challenges and limitations in their pursuit. This will provide motivation and more meaningful work.	**A**	**B**
11.05	**PLAYERS NEED TO BE FREE** to explore and learn through performing specific tasks better than any other method. They're literally and figuratively going through the motions—"actions are (the) interface."	**F**	**A**

ZONE A CLUSTERS

A1 - Goals + Limits

7.01	Games have clearly defined goals, giving players a “sense of purpose”.
7.02	Games exhibit rules and limitations to “unleash creativity and foster strategic thinking.”
7.10	Collectivity and shared goals give game actions and achievements great value. (98)
12.02	**REALISTIC GOALS + LIMITATIONS** Make sure that the game environment will spur players to form the right goals, and present them with realistic challenges and limitations in their pursuit. This will provide motivation and more meaningful work.

A2 - Challenge + Accommodation

5.02	Presents and encourages "preparation for future learning" through practice;
5.07	Does not "coddle" players;
6.02	**CHALLENGE** is the "desire for...effort and control—with the trait of conscientiousness," often correlated with players' difficulty level preferences
7.05	Games provide challenges and “unnecessary obstacles” that allow players to exercise their strengths. These obstacles are consciously chosen.

A3 - Agency + Engagement

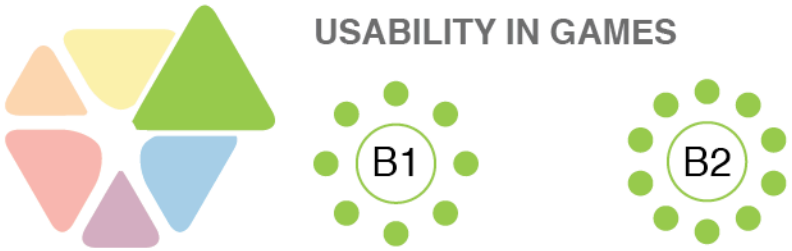
1.03	**AESTHETICS** are the emotional response a game elicits from a player. Aesthetics account for the game's ability to entertain and engage a player. Aesthetics include things like expression, discovery, sensation, challenge, and narrative. All of these aesthetics can be channels of action and feedback for players, channels that are essential in designing a successful game.
2.01	**KINESTHETIC INVOLVEMENT** is the ability to manipulate actors and environment within the game, and to take action that will result in a particular set of consequences; also referred to as agency.
2.02	**SPATIAL INVOLVEMENT**, in videogames, is the ability to perceive, explore and discover freely in a virtual environment.
2.04	**NARRATIVE INVOLVEMENT** is the ability of a player to affect a game's narrative through a series of actions, and the ability to experience a unique story through feedback
2.05	**AFFECTIVE INVOLVEMENT** is the ability to engage a player emotionally through a series of feedback between player and game system; the ability of a player to "customize" their experience through choices, and the system's ability to bring about certain outcomes through (action-specific) feedback
3.03	User control and freedom
5.01	A good game motivates players to play for extended periods of time;
8.05	Fun comes first; a game must entertain to engage.
11.01	**SHOW EMPATHY** by considering what genuine needs and desires a game fulfills to the user, as well as how those needs should be mapped into the game.
11.04	**THE PLAYER IS THE HERO**, not the designer. The process of the experience, not the content, should drive a game's design.
11.05	**PLAYERS NEED TO BE FREE** to explore and learn through performing specific tasks better than any other method. They're literally and figuratively going through the motions—"actions are (the) interface."

ZONE B

Item #	Description	Primary	Secondary
1.02	**DYNAMICS** refer to game's response to the player's efforts and achievements during play.	**B**	**A**
2.02	**SPATIAL INVOLVEMENT**, in videogames, is the ability to perceive, explore and discover freely in a virtual environment.	**B**	**C**
4.05	**TEAMWORK** in small groups helps learners better analyze and construct understanding of a subject. This exposes them to many perspectives.	**B**	**E**
5.15	Allows information to "trickle" to create a sense of urgency;	**B**	**F**
5.16	Fosters relationships and a sense of communication between game system and players through input and feedback;	**B**	**C**
5.25	Includes a diverse group of players who may interact and learn from each other.	**B**	**A**
6.03	**STIMULATION** indicates the degree of social interaction a player desires with other people, either for competition or collaboration	**B**	**A**
7.04	Acceptance of the rules and goals, as well as a level playing field for multiplayer games. This is what McGonigal refers to as voluntary participation—it indicates a player's "freedom to enter or leave a game at will".	**B**	**C**
7.06	Games facilitate flow, causing players to focus their energy in a positive way.	**B**	**A**
7.09	High engagement in games helps players build relationships and creates a sense of community.	**B**	**C**
7.11	Games provide greater motivation, and more wholly incite player investment.	**B**	**A**
7.13	Game structure encourages forming positive communities with shared goals, and is more inclusive.	**B**	**C**
7.17	Games are well organized and broken into many small tasks that can be completed by many players collaborating as a tightly knit team.	**B**	**C**
9.02	**BE INCLUSIVE** to accommodate users with different expertise, cultural heritage, and ability. Shneiderman calls this designing for *plasticity*.	**B**	**C**
9.03	**GIVE FREQUENT, TIMELY FEEDBACK** that indicates importance as well as accuracy. Feedback may be delivered visually, acoustically, spatially, haptically, and/or cognitively.	**B**	**C**

11.07	**GAMES SPEAK IN IMAGES**, so graphics are an important form of communication. In some ways, Squire writes, they become another gaming language necessary for players to thrive in a game.	**B**	**A**
11.08	**SHOW THE PLAYER IS WHAT IMPORTANT** by eliminating unnecessary or conflicting information (Squire, p. 21) Squire writes that this is one way to map a level of learning ideology into the game.	**B**	**F**
11.09	**GIVE THEM JUST ENOUGH** information to keep them interested and to allow them to play the game well. This creates urgency, while also allowing players to process information in smaller, more manageable chunks.	**B**	**F**
12.03	**FACILITATE FLOW** by giving players balanced challenges and achievements, all supported with adequate feedback. Give them a sense of purpose by making sure challenges are not too easy or too frivolous.	**B**	**C**
6.05	**THREAT** indicates the way players respond to unpleasant emotions created by the game such as fear, tension, or danger	**A**	**B**
2.03	**SHARED INVOLVEMENT** refers to the player's ability to interact with other players or automated components.	**C**	**B**
6.04	**HARMONY** is the level of cooperation required by a game. Do players prefer to work together or compete?	**C**	**B**

ZONE B CLUSTERS



B1 – Facilitate Flow

1.02	**DYNAMICS** refer to game's response to the player's efforts and achievements during play.
5.15	Allows information to "trickle" to create a sense of urgency;
6.05	**THREAT** indicates the way players respond to unpleasant emotions created by the game such as fear, tension, or danger
7.06	Games facilitate flow, causing players to focus their energy in a positive way.
7.11	Games provide greater motivation, and more wholly incite player investment.
7.17	Games are well-organized and broken into many small tasks that can be completed by many players collaborating as a tightly knit team.
11.07	**GAMES SPEAK IN IMAGES**, so graphics are an important form of communication. In some ways, Squires writes, they become another gaming language necessary for players to thrive in a game.
11.09	**GIVE THEM JUST ENOUGH** information to keep them interested and to allow them to play the game well. This creates urgency, while also allowing players to process information in smaller, more manageable chunks.

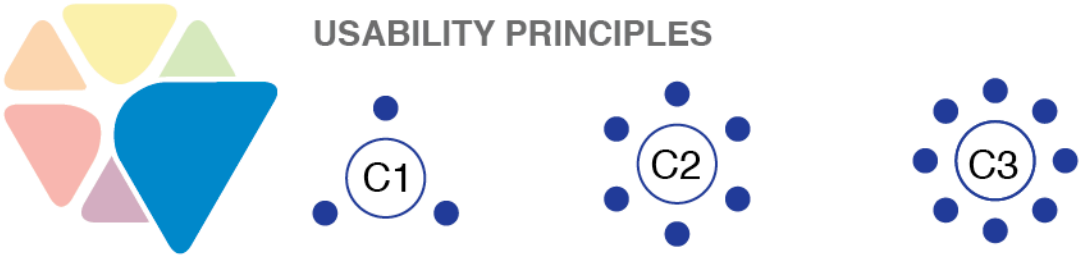
B2 – Culture & Collective Play

2.03	**SHARED INVOLVEMENT** refers to the player's ability to interact with other players or automated components.
4.05	**TEAMWORK** in small groups helps learners better analyze and construct understanding of a subject. This exposes them to many perspectives.
5.16	Fosters relationships and a sense of communication between game system and players through input and feedback;
5.25	Includes a diverse group of players who may interact and learn from each other.
6.03	**STIMULATION** indicates the degree of social interaction a player desires with other people, either for competition or collaboration
6.04	**HARMONY** is the level of cooperation required by a game. Do players prefer to work together or compete?
7.04	Acceptance of the rules and goals, as well as a level playing field for multiplayer games. This is what McGonigal refers to as voluntary participation—it indicates a player's "freedom to enter or leave a game at will".
7.09	High engagement in games helps players build relationships and creates a sense of community.
7.13	Game structure encourages forming positive communities with shared goals, and is more inclusive.
7.17	Games are well organized and broken into many small tasks that can be completed by many players collaborating as a tightly knit team.

ZONE C

Item #	Description	Primary	Secondary
1.01	**MECHANICS** refer to the pieces of the game that project information and patterns; they inform dynamics.	C	F
2.06	**LUDIC INVOLVEMENT** is a player's ability to select, set, and achieve goals through playful or willfully chosen means. Ludic involvement leads to self-competency and mastery.	C	F
3.01	Visibility of system status	C	A
3.04	Consistency and standards	C	B
3.05	Error prevention	C	B
3.07	Flexibility and efficiency of use	C	B
3.08	Aesthetic and minimalist design	C	D
3.10	Help and documentation	C	D
5.06	Offers players options;	C	A
5.17	Gives players room to customize their experiences and make mistakes;	C	B
5.19	Seamlessly integrates demos and actual gameplay, creating fluid transitions;	C	B
7.03	A rapid feedback system keeps players motivated and indicates progress toward achieving the goal.	C	B
7.07	Games are clearer and more engaging, making the work more satisfying for players.	C	B
8.04	Tailored games allow players to become more invested in achieving difficult tasks; this sparks flow.	C	D
9.01	**BE CONSISTENT** in layout, prompts, language, and action sequences. Anomalies should be kept to a minimum to prevent confusion.	C	B
9.04	**GIVE USERS CLEAR CONFIRMATION** when a task is completed successfully. This reassures and pleases the user while increasing trust in the system.	C	D
9.05	**REDUCE ERRORS** by designing a system that allows the user to make fewer errors and recover independently.	C	B
9.07	**THE USER IS IN CHARGE**, so a system must respond to the user. A weak communication loop, or monotonous or redundant tasks degrades the experience.	C	B
11.02	**SET THE STAGE** A virtual world often becomes real to its players, and so the environment and experience must be designed as such. It must be believable with its own set of mores. This includes explicit game rules and implicit cultural ones.	C	F
6.01	**NOVELTY** refers to a player's preference for familiarity in components of and challenges presented by a game; their desire for expected or unexpected events, continuity, sameness	A	C

ZONE C CLUSTERS



C1 – Intuitive Integration

3.07	Flexibility and efficiency of use
9.07	**THE USER IS IN CHARGE**, so a system must respond to the user. A weak communication loop, or monotonous or redundant tasks degrades the experience.
11.02	**SET THE STAGE** A virtual world often becomes real to its players, and so the environment and experience must be designed as such. It must be believable with its own set of mores. This includes explicit game rules and implicit cultural ones.

C2 – Communication

3.01	Visibility of system status
3.05	Error prevention
5.19	Seamlessly integrates demos and actual gameplay, creating fluid transitions;
7.03	A rapid feedback system keeps players motivated and indicates progress toward achieving the goal.
9.04	**GIVE USERS CLEAR CONFIRMATION** when a task is completed successfully. This reassures and pleases the user while increasing trust in the system.
9.05	**REDUCE ERRORS** by designing a system that allows the user to make fewer errors and recover independently.

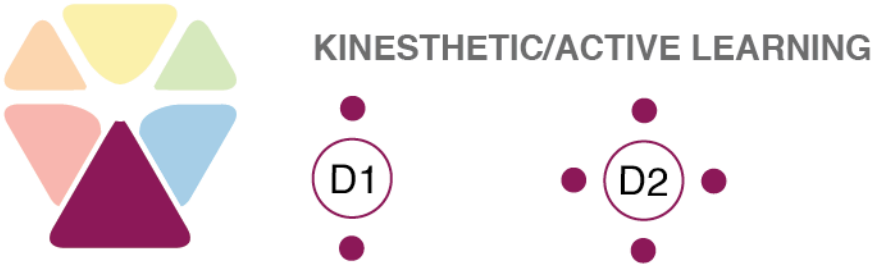
C3 – Custom Content

1.01	**MECHANICS** refer to the pieces of the game that project information and patterns; they inform dynamics.
2.06	**LUDIC INVOLVEMENT** is a player's ability to select, set, and achieve goals through playful or willfully chosen means. Ludic involvement leads to self-competency and mastery.
3.04	Consistency and standards
5.06	Offers players options;
5.17	Gives players room to customize their experiences and make mistakes;
6.01	**NOVELTY** refers to a player's preference for familiarity in components of and challenges presented by a game; their desire for expected or unexpected events, continuity, sameness
7.07	Games are clearer and more engaging, making the work more satisfying for players.
8.04	Tailored games allow players to become more invested in achieving difficult tasks; this sparks flow.

ZONE D

Item #	Description	Primary	Secondary
3.02	Match between system and the real world	**D**	B
3.06	Recognition rather than recall	**D**	F
3.09	Help users recognize, diagnose, and recover from errors through affordances, and feedback—both activational and behavioral. activational feedback - lets the user know an input was executed and received behavioral feedback – demonstrates the effects of a user's actions on the system; if an action was successful, he or she moves on. If not, he or she makes another attempt	**D**	E
5.18	Teaches players about the game's genre and how it works early in the game experience;	**D**	F
5.24	Provides players with a wide range of resources to learn about the game	**D**	C
11.03	**ROLEPLAY RULES** gaming. Players can test and assume different identities for both their avatars and themselves while learning the game's core values.	**D**	F

ZONE D CLUSTERS



D1 – Reasoning + Comprehension

3.06	Recognition rather than recall
3.09	Help users recognize, diagnose, and recover from errors through affordances, and feedback—both activational and behavioral activational feedback - lets the user know an input was executed and received behavioral feedback – demonstrates the effects of a user's actions on the system; if an action was successful, he or she moves on. If not, he or she makes another attempt

D2 – Realistic Metaphors for Transfer

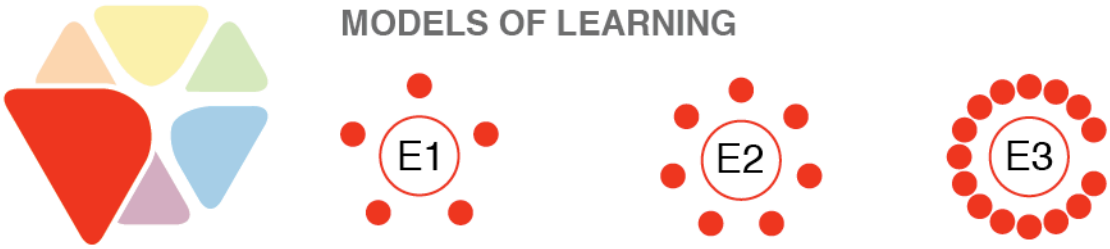
3.02	Match between system and the real world
5.18	Teaches players about the game's genre and how it works early in the game experience;
5.24	Provides players with a wide range of resources to learn about the game; and
11.03	**ROLEPLAY RULES** gaming. Players can test and assume different identities for both their avatars and themselves while learning the game's core values.

ZONE E

Item #	Description	Primary	Secondary
4.01	**WATCH + LEARN** by studying a problem in its natural context.	**E**	F
4.02	**PERCEPTION ANALYSIS** allows learners to really assess and make sense of information, giving them a chance to reason and form deeper meaning.	**E**	D
4.03	**CONTEXT IS KEY** to understanding; background research forms a more concrete understanding of a subject.	**E**	-
4.04	**A STUDENT-TEACHER relationship** in which learners observe and assist experts to increase their mastery of a subject.	**E**	B
4.06	**MANY PERSPECTIVES** allow students to expand their understanding, or to work toward mastery through a horizontal learning experience.	**E**	F
4.07	**MANY APPLICATIONS** of the same knowledge by others will further enhance a learner's understanding of a subject.	**E**	D
5.03	Presents opportunities for horizontal *and* vertical learning experiences;	**E**	F
5.05	Encourage learners to self-evaluate and self-direct,	**E**	F
5.11	Teaches skill sets, and demonstrates how and why they are to be learned;	**E**	F
5.12	Urges players to observe skills in solving simple problems in the form of demos;	**E**	D
5.14	Presents and repeats information in many formats so that it will be understood and retained by players of many learning styles;	**E**	F
5.21	Pushes players to push themselves and their limits to achieve potential;	**E**	A
5.22	Presents players with constant challenges to apply what they've learned while also learning new things;	**E**	B
7.16	Games inspire players to achieve larger than life feats, or "epic wins". (252)	**E**	F
9.06	**ALLOW USERS TO STEP BACK** by designing a system in which users can return to a previous step or "undo" an action. This reduces fear of failure.	**E**	A
9.08	**BE INTUITIVE** in a design to lessen some of the user's burden. Psychological chunking and simplifying tasks reduces cognitive and short-term memory load.	**E**	D
10.01	**DIET** Make positive dietary choices, understand nutritional values, or how certain foods may affect the body.	**E**	F
10.02	**EXERCISE** Increase activity, explore the relationship between food, insulin, and exercise, or learn about the importance of weight control.	**E**	A
10.03	**MONITOR** organ function, glucose levels, weight, and other medical metrics; learn to decipher these figures.	**E**	F

10.04	**MEDICATE** learn about the effects, roles, and function of different medicines, as well as how to administer and adjust them.	**E**	-
10.05	**PROBLEM SOLVING** can help PWDs learn to take care of themselves or seek help in the event of an emergency, as well as how to manage their disease more independently. This may also include establishing coping mechanisms.	**E**	B
10.06	**SAFETY** how to reduce long-term health risks of diabetes, as well as how to recognize and respond to side effects of diabetes or diabetes treatment.	**E**	-
10.07	**COPING** strategies help PWDs stay healthy and positive. Social networks, motivation, and attitude are key to healthy coping behavior.	**E**	B

ZONE E CLUSTERS



E1 – Problem Solving + Processing

5.22	Presents players with constant challenges to apply what they've learned while also learning new things;
9.06	**ALLOW USERS TO STEP BACK** by designing a system in which users can return to a previous step or “undo” an action. This reduces fear of failure.
9.08	**BE INTUITIVE** in a design to lessen some of the user’s burden. Psychological chunking and simplifying tasks reduces cognitive and short-term memory load.
10.05	**PROBLEM SOLVING** can help PWDs learn to take care of themselves or seek help in the event of an emergency, as well as how to manage their disease more independently. This may also include establishing coping mechanisms.
12.04	**GIVE PLAYERS TIME**, not just to build skill and achieve their goals, but also to reflect on their mistakes, their achievements, and their learning experience.

E2 – Guided Construction

4.04	**A STUDENT-TEACHER relationship** in which learners observe and assist experts to increase their mastery of a subject.
4.06	**MANY PERSPECTIVES** allow students to expand their understanding, or to work toward mastery through a horizontal learning experience.
4.07	**MANY APPLICATIONS** of the same knowledge by others will further enhance a learner's understanding of a subject.
5.03	Presents opportunities for horizontal *and* vertical learning experiences;
5.11	Teaches skill sets, and demonstrates how and why they are to be learned;
5.14	Presents and repeats information in many formats so that it will be understood and retained by players of many learning styles;
10.08	**LEARN** improve comprehension and mastery through regular review and exposure to new information. In gaming this may be accomplished through *infinite games*.

E3 – Modeling + Mentorship

4.02	**PERCEPTION ANALYSIS** allows learners to really assess and make sense of information, giving them a chance to reason and form deeper meaning.
4.03	**CONTEXT IS KEY** to understanding; background research forms a more concrete understanding of a subject.
5.05	Encourage learners to self-evaluate and self-direct,
5.12	Urges players to observe skills in solving simple problems in the form of demos;
5.21	Pushes players to push themselves and their limits to achieve potential;
7.16	Games inspire players to achieve larger than life feats, or "epic wins".
8.03	Games that provide characters exhibiting positive behavior provide a better model for players to observe and emulate.
10.01	**DIET** Make positive dietary choices, understand nutritional values, or how certain foods may affect the body.
10.02	**EXERCISE** Increase activity, explore the relationship between food, insulin, and exercise, or learn about the importance of weight control.
10.03	**MONITOR** organ function, glucose levels, weight, and other medical metrics; learn to decipher these figures.
10.04	**MEDICATE** learn about the effects, roles, and function of different medicines, as well as how to administer and adjust them.
10.06	**SAFETY** how to reduce long-term health risks of diabetes, as well as how to recognize and respond to side effects of diabetes or diabetes treatment.
10.07	**COPING** strategies help PWDs stay healthy and positive. Social networks, motivation, and attitude are key to healthy coping behavior.
11.06	**CONSTRUCT LEARNING ENVIRONMENTS** through social interaction and/or different problem solving scenarios.

ZONE F

Item #	Description	Primary	Secondary
5.02	Presents and encourages "preparation for future learning" through practice;	**F**	**E**
5.08	Does not require players to know more than the basics before play begins;	**F**	**B**
5.09	Creates opportunities for players with different levels of expertise—even “nubes” can be experts in some things;	**F**	**E**
5.10	Provides basic instruction in increasingly difficult levels to help the player practice and understand the game;	**F**	**B**
5.13	Allows them to test new skills on gradually more complex problems (practice);	**F**	**B**
5.20	Merges learning and play;	**F**	**B**
5.23	Allows players to learn and play at their own pace, making it okay to fail and re-attempt;	**F**	**E**
8.01	Knowledge and skill must both be attained to facilitate behavior change.	**F**	**E**
11.10	**A GAME IS WHAT A PLAYER MAKES IT**—players have lots of options, lots of paths they can take, and thus many ways of perceiving and constructing meaning from those experiences. This is a good thing.	**F**	**B**
12.01	Create a relationship between the game’s pattern and a desired, unknown pattern in reality. The concepts being mapped must share a similar domain.	**F**	**B**
5.04	Creates a low-stakes game environment;	**A**	**F**
7.12	Games reward effort more than achievement, encouraging internal motivation.	**B**	**F**
7.14	Games are “happiness hacks”, allowing players to use something they already enjoy to learn new patterns and solve new problems.	**A**	**F**

ZONE F CLUSTERS

F1 – Flexible Direction

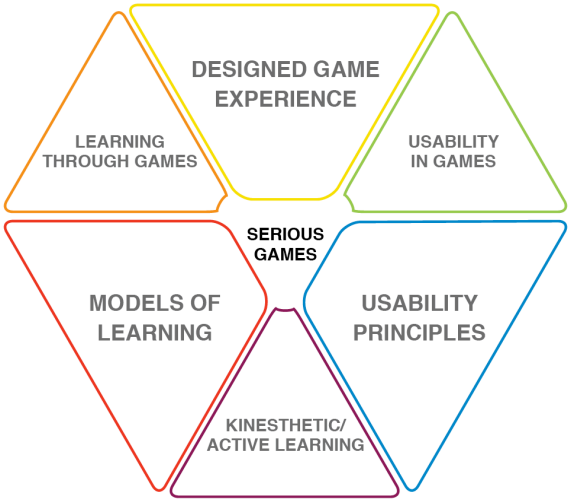
5.08	Does not require players to know more than the basics before play begins;
5.09	Creates opportunities for players with different levels of expertise—even "nubes" can be experts in some things;
5.10	Provides basic instruction in increasingly difficult levels to help the player practice and understand the game;
5.23	Allows players to learn and play at their own pace, making it okay to fail and re-attempt;
11.10	**A GAME IS WHAT A PLAYER MAKES IT**—players have lots of options, lots of paths they can take, and thus many ways of perceiving and constructing meaning from those experiences. This is a good thing.

F2 – Competency + Confidence

5.02	Presents and encourages "preparation for future learning" through practice;
5.04	Creates a low-stakes game environment;
5.13	Allows them to test new skills on gradually more complex problems (practice);
5.20	Merges learning and play;
7.12	Games reward effort more than achievement, encouraging internal motivation.
7.14	Games are "happiness hacks", allowing players to use something they already enjoy to learn new patterns and solve new problems.
8.01	Knowledge and skill must both be attained to facilitate behavior change.
12.01	Create a relationship between the game's pattern and a desired, unknown pattern in reality. The concepts being mapped must share a similar domain.

4.3 Step 4: Comprehensive list of synthesized criteria, definition of criteria

Criteria were synthesized and refined. The final evaluation model includes three criteria for each of the three major categories (Gameplay, Learning, and Usability). Overlap zones between the major zones include two criteria to create a more balanced, more comprehensive evaluative model. The model that follows is proposed as a tool for design guidance and evaluation of health-focused serious games.



The new model (next page) is balanced between game experience and game design, demonstrating the equilibrium Lieberman says is essential to creating good games. Finally, Zones D and E are specific to health and serious games. Because these account for one third of the score, a commercial game will not be able to score much more than two thirds of the total points. Similarly, edutainment and gamified experiences will not be able to score well in the learning (Zones A and F) and game design-specific areas (Zones B and C), respectively.

4.3.1: Summary of proposed model

A	1. **Goals + Limits:** Maps clearly defined objectives into play patterns, motivating player to explore and learn, either individually or independently, while teaching players the possibilities and limits on their way to achieving goals.
	2. **Challenge + Accommodation:** Provides difficult but achievable challenges to motivate players to push the limits. Teaches players new skills through these challenges, and presents them with opportunities to exercise and test them.
	3. **Facilitate Flow:** Seeks to meet player's needs by giving them freedom to act/choose, explore, and discover through gameplay. Engages players by immersing them in activities, tasks, and/or story. This is facilitated by clear, regular feedback.
B	4. **Agency + Engagement:** Balances challenges and achievement by giving players just enough information to understand and work toward completing challenges independently, while helping them to focus by providing focused perceptual feedback (i.e., emotional, visual, audio, or conceptual), and does so in a timely manner.
	5. **Culture + Collective Play:** Increases players' understanding of game objectives, values, and culture through social interactions (with virtual or actual characters) and proximal learning. Offers many perspectives so that players may interpret and construct their own understanding.
C	6. **Intuitive Integration:** Improves experience by anticipating players' needs and wants. Responds by providing a variety of fresh, flexible play opportunities in a metaphorical, yet believable environment.
	7. **Communication:** A game responds to player input with frequent, clear feedback. Cues help a player track progress, while also helping them to avoid mistakes and misunderstandings.
	8. **Custom Content:** Affords many options and paths toward understanding and achieving goals as they work toward increasing competency and mastery. Players' objectives must be mapped into these paths clearly and consistently.
D	9. **Reasoning + Comprehension:** Exposes the player to multiple experiences that reinforce the objectives and help the player recognize a pattern of action and consequence. Encourages a player to construct a logical understanding, and reinforces these understandings through feedback.
	10. **Realistic Metaphors for Transfer:** Creates a parallel between the problems and learned skills in the game and those in reality. This allows the player to understand both more thoroughly, and test them in different contexts by putting the player directly into the problem scenario. Role-play, for example, may allow a player to learn how to adopt behavior or skills.
E	11. **Problem Solving + Processing:** Pushes players to apply what they've learned in incrementally challenging and abstract ways. Allows them to reflect on learning, as well as reattempt challenges to better understand the underlying patterns and/or metaphors.
	12. **Guided Construction:** Directs constructed knowledge through observation, application, and trial-and-error. Encourages players to understand a problem from many perspectives, as well as how and why some solutions are better than others. Repetition and multiple contexts further comprehension.
	13. **Behavior Modeling + Mentorship:** Maps health behavioral objectives into demonstrations, character interactions, and game environments. Facilitates modeled behavior and proximal learning, while motivating players to set greater goals and self-assess.
F	14. **Flexible Direction:** Allows players to move at their own pace, creating challenges for players with varied expertise. Provides ample opportunities to practice, as well as gentle direction that embrace the unique constructed understanding formed through gameplay.
	15. **Competency + Confidence:** Boosts players' confidence by with an emphasis on effort and improvement, encouraging players to test skills and knowledge. Increases competency and facilitates behavioral change through merged learning and play.

4.3.2: Establishing a decision guide for scoring

Establishing reliability, accuracy, and validity are important in the analysis of any data set, and to neglect them would be a detriment to the integrity of the proposed model. In evaluations of usability, however, it can be especially difficult to ensure objectivity among evaluators. As a qualitative evaluative tool, there are several limitations to the model proposed in this thesis. The major advantage of formative evaluations is that they may also be used after the summative evaluation, or on an interim basis. This ensures that the product or service will continue to adapt and change to meet the needs of its users.[187]

This model is proposed as a formative evaluation seeking to improve the quality of health-focused serious games. These types of evaluations are intended to be flexible and responsive through the development process. They are not meant to fail a project, but instead to identify areas for improvement and growth. They may influence the summative evaluations used to determine overall efficacy, however, they are not the final measure of a project's success.

One way to reduce variability among evaluators using this model is to set performance standards, which establish benchmarks of acceptability. Daniel Stuffelbeam, author and professor at Western Michigan University's Evaluation Center, explains what types of evaluation are appropriate during stages of the project cycle:

> "…evaluations should be comparative before the purchase of a product or service or the beginning of a program, non comparative during program

development or use of a service, and periodically comparative after development or sustained use to open the way for improvements or better alternatives…"[188]

He suggests defining the key evaluation questions with set crucial criteria of acceptability.

The proposed model is made up of 15 criteria, which serve as the key evaluation questions. The proposed model is designed as a tool for developers of health-focused serious games. Certain aspects of the games being developed such as health-focused content serve as absolute cut rules, however factors affecting the decided value of each criteria must also be more clearly defined if the evaluation is to be used effectively and consistently. To do so, Stufflebeam urges evaluative designers to establish a decision rubric. Key aspects of each of the proposed model's criteria may easily be adapted to this purpose.

Social scientist Kathleen MacQueen serves as coordinator of Interdisciplinary Research Ethics at Family Health International in Durham. MacQueen's work focuses largely on team-based qualitative research in the social sciences. Information in this field is frequently collected via open-ended surveys and focus groups, and is also analyzed by multiple individuals. She assures us that the best way to minimize variability among evaluators is to develop some sort of "code" for all users of the evaluation to use.

In order to find patterns and analyze them accurately, research teams often develop codebooks similar to Stufflebeam's decision rubric to determine how patterns and responses should be recorded. "Codes," MacQueen writes, "are the building blocks

for theory or model building, and the foundation on which the analyst's arguments rest."[189] She further writes that a codebook should contain the following: "the code, a brief definition, a full definition, guidelines for when to use the code, guidelines for when not to use the code, and examples."[190] To improve the use of the proposed model, a similar guide combining codes and rules for decision-making has been included on the following pages. First, however, it is important to understand the scoring process.

Rule-based scoring was selected as a method, leading to the development of this decision guide. Each of the fifteen model criteria may receive a maximum score of 4. One point will be given for each of the four rules supporting that criterion. If a rule is satisfied, it is coded with a one (+1). If a rule is not satisfied, it is coded with a zero (0). The sum total of each primary and each secondary zone will be used to calculate two things: a composite score, and a balance score.

The total score is the sum of points for all rules. It is used to indicate overall quality of the game experience. The balance score uses the sum of the sub-categories (each composed of one primary and one secondary zone's points) to indicate how well a game balances elements of gameplay, learning, and usability. A "Satisfactory" health-focused serious game will be high-scoring and balanced, while an "Unsatisfactory" game will be low-scoring and unbalanced.

FIGURE 4.3, Calculating the balance score

FORMULA

Score A + Score B = Sum 1
Score C + Score D = Sum 2
Score E + Score F = Sum 3

$$\frac{\{(\text{Sum 1} / \text{High Score}) + (\text{Sum 2} / \text{High Score}) + (\text{Sum 3} / \text{High Score})\}}{3} = \text{Balance Score}$$

EXAMPLE

	A	B	Sum1	C	D	Sum2	E	F	Sum3	Balance Score	Total Score
SET 1	9	7	16	10	8	18	9	8	17	.94	51
SET 2	11	2	13	10	2	12	5	6	11	.92	36
SET 3	11	7	18	8	2	10	5	3	8	.67	36

SET SCORES

Set 1 $\frac{(16/18) + (18/18) + (17/18)}{3} = \frac{.89 + 1 + .94}{3} = \frac{2.83}{3} = .94$ **Balanced, Higher Score**

Set 2 $\frac{(13/13) + (12/13) + (11/13)}{3} = \frac{1 + .92 + .85}{3} = \frac{2.77}{3} = .92$ **Balanced, Neutral Score**

Set 3 $\frac{(18/18) + (10/18) + (8/18)}{3} = \frac{1 + .56 + .44}{3} = \frac{2}{3} = .67$ **Unbalanced, Neutral Score**

So, as you can see, games with low or neutral overall scores may still receive a high balance score. High-scoring games, likewise, may receive a low balance score. A health-focused serious game will have a high balance score, but the best health-focused serious games will have both a high overall score and a high balance score.

ZONES A + B

Zone	Criteria	Brief Definition	Full Definition
A	1.	**Goals + Limits**	Maps clearly defined objectives into play patterns, motivating player to explore and learn, either individually or independently, while teaching players the possibilities and limits on their way to achieving goals. 1 Contains clearly defined objectives. **Example:** Maintaining health by destroying harmful cells with the right medicines. 2 Rewards exploration. **Example:** Bonus points for discovering hidden content. 3 Facilitates learning. **Example:** Challenges build skill through experience, practice, and problem solving. Applying skills from previous challenges in new ones is an example of learning. 4 Indicates options for success, as well as rules and limits. **Example:** A player must complete 3 laps on a track to win, but must do so in 3 limits or less.
	2.	**Challenge + Accommodation**	Provides difficult but achievable challenges to motivate players to push the limits. Teaches players new skills through these challenges, and presents them with opportunities to exercise and test them. 1 Teaches players new skills within the game. **Example:** Learning how to use diet to control glucose levels and functionality. 2 Challenges require effort and application to achieve success. **Example:** Increasing speed and accuracy are required to defeat a foe. 3 Encourages players to try new things. **Example:** Using special maneuvers or combinations of skills to complete a challenge. 4 Provides multiple opportunities to practice skill. **Example:** Repeatable challenges, or repetition of similar problems.
	3.	**Facilitate Flow**	Seeks to meet player's needs by giving them freedom to act/choose, explore, and discover through gameplay. Engages players by immersing them in activities, tasks, and/or story. This is facilitated by clear, regular feedback. 1 Provides players with choices. **Example:** Players may choose level of difficulty, challenges, or character features. 2 Creates a sense of discovery. **Example:** Hidden features, bonuses, or skills. 3 Enables players to focus. **Example:** Action is targeted to addressing, tasks, or completing a story to immerse the player in challenges. 4 Reinforces action and exploration through feedback. **Example:** Challenges are broken into smaller, more manageable tasks, which are encouraged through positve feedback (such as earned points) or negative feedback (sustaining damage to an avatar).
B	4.	**Agency + Engagement**	Balances challenges and achievement by giving players just enough information to understand and work toward completing challenges independently, while helping them to focus by providing focused perceptual feedback (i.e., emotional, visual, audio, or conceptual), and does so in a timely manner. 1 Balances challenges and achievement. **Example:** Success in difficult challenges are met with greater rewards. For example, completing a task in a more efficient way may be rewarded with additional points or advantages. 2 Provides with essential information. **Example:** Players are given basic instruction devoid of extranneous details. If there are bonus features, these may not be shared to decrease distraction from main problem, or to maintain an element of discovery. 3 Provides targeted feedback. **Example:** Games may use vibration, visual impairment, or alarms to indicate a player has made an error or sustained a hit. 4 Delivers feedback in a reasonable amount of time. **Example:** Awarding or detracting points as errors or accomplishments are made.
	5.	**Culture + Collective Play**	Increases players' understanding of game objectives, values, and culture through social interactions (with virtual or actual characters) and proximal learning. Offers many perspectives so that players may interpret and construct their own understanding. 1 Helps player understand game's values and culture. ***Example:*** *Teamwork or competition may be a value of MPGs, Recognition or social standing may also be a part of the culture.* 2 Includes social interaction. **Example:** Interaction with an avatar guide or other players. 3 Facilitates proximal learning. **Example:** Team challenges or competition may help a player improve skill, as may providing guidance to others. 4 Includes diverse perspectives. **Example:** Players may experience a challenge as different characters.

ZONES C + D

Zone	Criteria	Brief Definition	Full Definition
C	6.	**Intuitive Integration**	Improves experience by anticipating players' needs and wants. Responds by providing a variety of fresh, flexible play opportunities in a metaphorical, yet believable environment. 1 Anticipate's a player's needs. **Example:** Need for guidance, approval, competition, etc. 2 Play is varied and flexible. **Example:** Many types of games, varied environments, varied skill, varied constraints, etc. 3 Challenge and play are metaphorical and similar to a problem relevant to the player. **Example:** A game in which players must protect or liberate others may help them understand how to stand up to bullies. 4 Play environment is believable. **Example:** Avatars and situation are logicaly paired with environment, i.e., space rangers are battling aliens in space, not fighting Girl Scouts in a volcano.
	7.	**Communication**	A game responds to player input with frequent, clear feedback. Cues help a player track progress, while also helping them to avoid mistakes and misunderstandings. 1 Game responds to player input. **Example:** Game signals players that they have made an error using warnings (flashing red lights or alarms). 2 Feedback is frequent and clear. **Example:** If a player is moving in the wrong direction, a warning signal may be visible or audible until the player is back on course. 3 Players are able to track progress using cues provided in the game. **Example:** A map indicating position in a course, or information regarding skill level are included in the interface. 4 Includes feedback for both mistakes and accomplishments. **Example:** Indicating when a player completes a task, or indicates areas of improvement through immediate feedback or post-challenge debriefing.
	8.	**Custom Content**	Affords many options and paths toward understanding and achieving goals as they work toward increasing competency and mastery. Players' objectives must be mapped into these paths clearly and consistently. 1 Includes horizontal and vertical experiences so players may choose their goals. **Example:** Players may choose to focus on points attained, mastery of technique, or the level of difficulty in play. 2 Includes many measures of success. **Example:** In addition to overall completion, a player may be rewarded for discovering hidden content, or completing a challenge quickly. 3 Provides reinforcement for behaviors and outcomes to increase competency/mastery. **Example:** Use of badges or granting special privileges when a player reaches a goal may increase self-confidence. 4 Players' objectives are mapped into game objectives. **Example:** If a player wants to level up individually, a battle mode may meet both the player's and the game's objectives.
D	9.	**Reasoning + Comprehension**	Exposes the player to multiple experiences that reinforce the objectives and help the player recognize a pattern of action and consequence. Encourages a player to construct a logical understanding, and reinforces these understandings through feedback. 1 Game experiences reinforce objectives. **Example:** Overcoming obstacles by taking desired actions provides positive reinforcement; likewise, winning by *not* performing undesirabile behavior negatively reinforces them. 2 Mechanics demonstrate patterns of cause and effect. **Example:** Speeding faster and avoiding collisions results in shorter race times. 3 Consequences of gameplay encourage player to evaluate these patterns. **Example:** Positive outcomes of behavior in a game may cause players to perceive it as a positive course of action in similar situations in their own lives. 4 Patterns and objectives are reinforced through feedback. **Example:** Debriefing may summarize a player's strengths and weaknesses, as well as why a mission succeeded or failed.
	10.	**Realistic Metaphors for Transfer**	Creates a parallel between the problems and learned skills in the game and those in reality. This allows the player to understand both more thoroughly, and test them in different contexts by putting the player directly into the problem scenario. Role-play, for example, may allow a player to learn how to adopt behavior or skills. 1 Challenges reflect a need for desired skills. **Example:** Levels build on each other. In *Re-Mission*, Roxxi kept patients healthy by administering medication and destroying harmful cells. 2 Gameplay creates a parallel between game and reality. **Example:** Challenges and actions a player faces in the game are similar to those faced in reality; using ammunition to kill off cancer monsters in *Re-Mission* is easily paralleled to actual cancer treatment. 3 An active role encourages player to demonstrate desired behavior. **Example:** Player performs desired behavior, and through avatar experiences effects. 4 Repetition of similar experiences promotes personal adoption of values or skills. **Example:** Player may easily model behavior of a character. For example, a player may choose to exercise more or try certain techniques after playing sports-themed games.

ZONES E + F

Zone	Criteria	Brief Definition	Full Definition
E	11.	**Problem Solving + Processing**	Pushes players to apply what they've learned in incrementally challenging and abstract ways. Allows them to reflect on learning, as well as reattempt challenges to better understand the underlying patterns and/or metaphors. 1 Skills are applied in increasingly dificult ways. **Example:** Tracks in a racing game may become longer or more complex to challenge players to develop and refine skills. 2 Game includes opportunities for reflection and self-evaluation. **Example:** Including practice levels or mini-challenges intermittently may help a player better understand abilities and areas for improvement. 3 Player is encouraged to re-attempt challenges. **Example:** If a challenge or task is failed, the player may repeat it or return to previous ones to improve and practice for future play. 4 Content is framed appropriately for player's level of understanding. **Example:** The game is appropriate to the player's level of experience and understanding; the intended player would be able to form a reasonable understanding of the game's experiences and objectives.
	12.	**Guided Construction**	Directs constructed knowledge through observation, application, and trial-and-error. Encourages players to understand a problem from many perspectives, as well as how and why some solutions are better than others. Repetition and multiple contexts further comprehension. 1 Player observes or practices skill before applying and/or testing. **Example:** The game includes demos or practice levels without negative consequences. 2 Game guides construction of knowledge through challenges or other characters. **Example:** A mentor figure models behavior or "Help" command provides player with explanations or assistance when requested. 3 Challenges encourage players to evaluate alternatives. **Example:** Eating a piece of cake versus eating a piece of fruit to fuel an avatar. 4 Helps a player build skill through practice and repetition. **Example:** Similar tasks are included in multiple levels and contexts.
	13.	**Behavior Modeling + Mentorship**	Maps health behavioral objectives into demonstrations, character interactions, and game environments. Facilitates modeled behavior and proximal learning, while motivating players to set greater goals and self-assess. 1 Health behaviors are incorporated into gameplay. **Example:** A player is or comes into contact with another character with similar health issues. May also learn about health behavior through character interaction. 2 Desired health behaviors are incorporated in a positive, easily transferrable way. **Example:** Exhibiting desired health behavior will benefit character or player in some way, contributing to the player's success in the game. 3 Game attempts to motivate players to set personal goals. **Example:** The game may alert a player for achieving personal milestones such as a high score or a new personal best. 4 Players are encouraged to self-assess. **Example:** Players may self-assess by reviewing their own stats or comparing their ability with the abilities of more advanced players.
F	14.	**Flexible Direction**	Allows players to move at their own pace, creating challenges for players with varied expertise. Provides ample opportunities to practice, as well as gentle direction that embrace the unique constructed understanding formed through gameplay. 1 Players control the pace of progression through a game. **Example:** A player may repeat or review a level or skill at any time without penalty. 2 The game is inclusive to many players of differing ability or expertise. **Example:** Players may choose from different ability levels (novice to expert), or they may choose to engage in game activities that build mastery, such as "battle mode" to improve strategy. 3 Provides many opportunities to practice different skills. **Example:** One challenge or level may focus on one skill, such as swordplay, while another may focus on agility or problem-solving. 4 Players receive assistance and instruction as needed. **Example:** At beginning of game, new level, or when asked. ("Help" section.)
	15.	**Competency + Confidence**	Boosts players' confidence by with an emphasis on effort and improvement, encouraging players to test skills and knowledge. Increases competency and facilitates behavioral change through merged learning and play. 1 Emphasis is on effort, not performance. **Example:** Small successes are celebrated in gameplay, as is perseverence. Growth and effort are recognized. 2 Challenges players to test knowledge and skill. **Example:** Challenges requiring combination of different skills to succeed, such as strategy and foresight to prevent another player's advantage in *Scrabble*. 3 Increases competency through reinforcement and affirmation. **Example:** Success in one challenge is rewarded with praise for progress and a greater challenge. 4 Play is used as a tool, not simply a reward. **Example:** Implicit learning in games like *Scrabble* or *Guess Who* allows a player to learn simply by doing.

4.4 Step 5: Application of proposed model for health-focused serious games

The resulting set of criteria was then used to form an evaluative tool for assessing health-focused serious games. To show how the proposed model may be used for evaluation, it was applied to five games—one commercial game (*Skylanders Giants*), one health-focused serious game with demonstrated success (*Re-Mission*), and three games targeted to kids living with diabetes.

FIGURE 4.4a, Games Used for Evaluation

CONTROL GAMES		DOMAIN-SPECIFIC HEALTH-FOCUSED SERIOUS GAMES		
1. Skylanders Giants	*2. Re-Mission*	*3. Carb Counting with Lenny the Lion*	*4. Shreddin' Diabetes*	*5. The Diabetic Dog*

The first domain-specific game, *Carb Counting with the Lion*, is an example of an educational game. The second, *Shreddin' Diabetes*, is an example of edutainment. The third and final game, *The Diabetic Dog*, is classified as a health-focused serious game. Each game was evaluated after a 45-minute play period. This duration was selected because this is the average amount of time children in this age group are able to fully concentrate on a task.[191] Although children did not evaluate the games, it was determined this would be sufficient time to indicate a game's ability to engage a player.

Each model item was given a score based on the Decision Guide. Numbers range from 0 to 4, with one point given to each of the rules satisfied under the criteria. It should be noted that *Skylanders* does have learning objectives beyond those of a purely entertaining commercial game, and that serious games were scored differently based on the number of health behaviors mapped into the game. The following pages include evaluation of each of the five games listed above with brief commentary on the overall game experience.

FIGURE 4.4b, Summary of Games for Evaluation

GAME TITLE	OBJECTIVES	GENRE	AGE	PLATFORM	CLASS
Skylanders Giants (2012)	Advance skill; increase avatar level through task completion, competition, and team tasks	Action/ Shooter	10+	Play Station 3, XBox 360, Nintendo Wii	Commercial Game
Re-Mission (2006)	Increase knowledge, retention,and ability to understand the importance of treatment adherance; to encourage treatment adherance	Shooter	13+	PC (Windows)	Health-Focused Serious Game
Carb Counting with Lenny the Lion (2010)	Help players learn about nutrition and practice dietary planning.	Quiz	4-12	Online, later launched for mobile	Health-Focused Educational Game
Shreddin' Diabetes (2010)	Increase awareness of nutrition and its role in glucose management; to demonstrate the relationship between blood glucose, diet, and exercise	Sports	General/ All Ages	Online only	Health-Focused Edutainment
The Diabetic Dog (2009)	Increase understanding of how insulin, diet, and exercise affect blood glucose level; to afford players practice opportunities to manage health	Simulation/ Educational	General/ All Ages	Online only	Health-Focused Serious Game

Chapter 5. DISCUSSION

5.1 Evaluation Results and Analysis

Game 1: Skylanders Giants

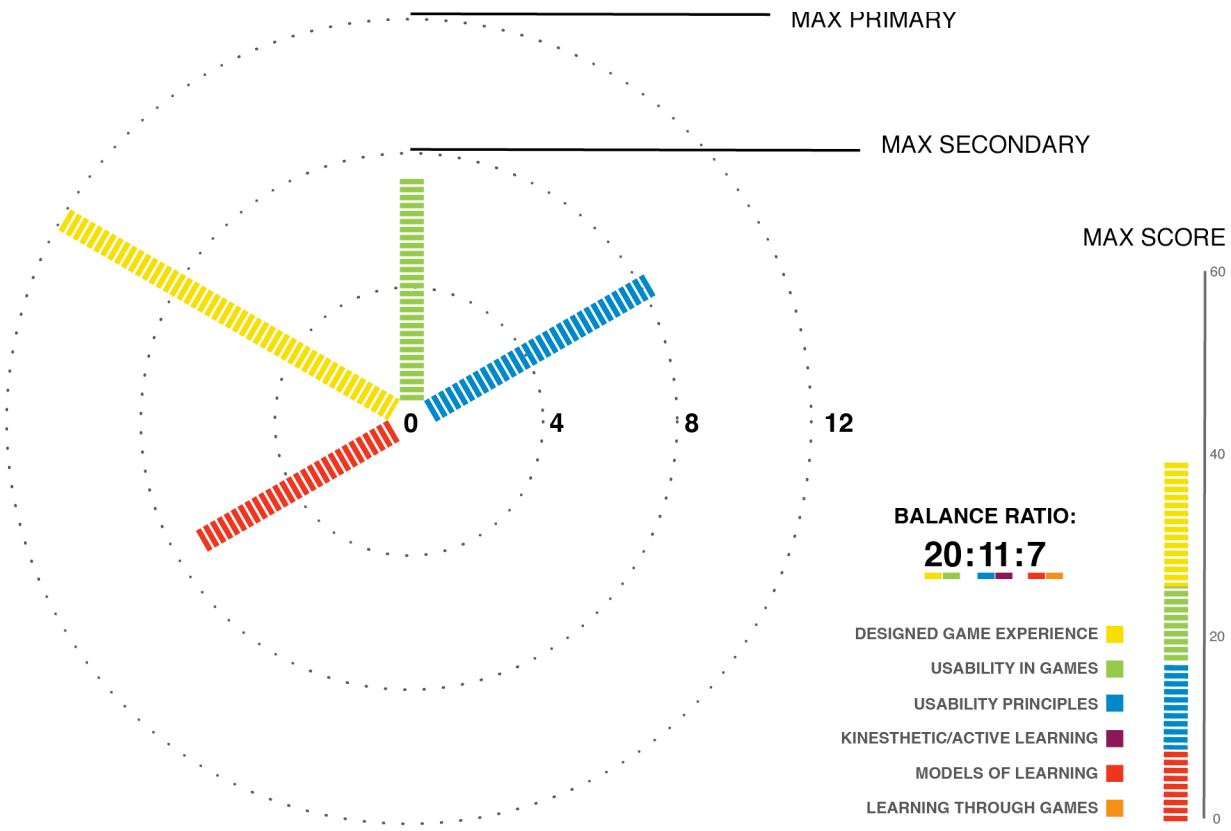
GAME SUMMARY Villainous Kaos has traveled back in time to oppress the group of Giants that established the Skylands, home of the Skylanders. Skylanders must go back in time to join forces with the Giants and defeat Kaos and his evil Arkeyan robots.

TABLE 5.1, Skylanders Giants Evaluation

	Poor	Fair	Neutral	Good	Excellent
1. Goals + Limits	☐	☐	☐	☐	☑
2. Challenge + Accommodation	☐	☐	☐	☐	☑
3. Facilitate Flow	☐	☐	☐	☐	☑
4. Agency + Engagement	☐	☐	☐	☐	☑
5. Culture + Collective Play	☐	☐	☐	☐	☑
6. Intuitive Integration.	☐	☐	☐	☑	☐
7. Communication	☐	☐	☐	☐	☑
8. Custom Content	☐	☐	☐	☐	☑
9. Reasoning + Comprehension	☑	☐	☐	☐	☐
10. Realistic Metaphors for Transfer	☑	☐	☐	☐	☐
11. Problem Solving + Processing	☑	☐	☐	☐	☐
12. Guided Construction	☑	☐	☐	☐	☐
13. Behavior Modeling + Mentorship	☑	☐	☐	☐	☐
14. Flexible Direction	☐	☐	☐	☑	☐
15. Competency + Confidence	☐	☐	☐	☐	☑

Total Score:
38 / 60

FIGURE 5.1, Score Summary for Skylanders



Skylanders Giants serves as a control game for testing the model as an evaluative tool. This game is a current, top-rated game. The game scored well in all areas except those specific to health and health behavior.

The game's strengths lay in its opportunities for social interaction and agency. Each *Skylanders* figure has its own personality and strengths, granting it specific advantages when playing in certain game environments and with other players whose character also offers individual strengths that may help in a challenge. Supporting characters frequently speak to player avatars during challenges, too, adding dimension

to character interactions. Players are given freedom to explore, and are, in fact, rewarded for exploration with hidden levels with extra points and rewards.

In addition to being highly customizable, players are also given frequent and focused feedback. Visuals helping them track progress, status, and location are ever present. Auditory feedback is regularly used to signal upcoming obstacles and time lapse during steps of each task. Together these create a sense of urgency and excitement. Each level is followed by a short debriefing period in which players are allowed to purchase power-ups for their avatars and receive instructions for the next challenge. They may also choose their own measures of success—the game offers scores for challenge completion, attainment of items or markers, as well as speed.

Game 2: Re-Mission

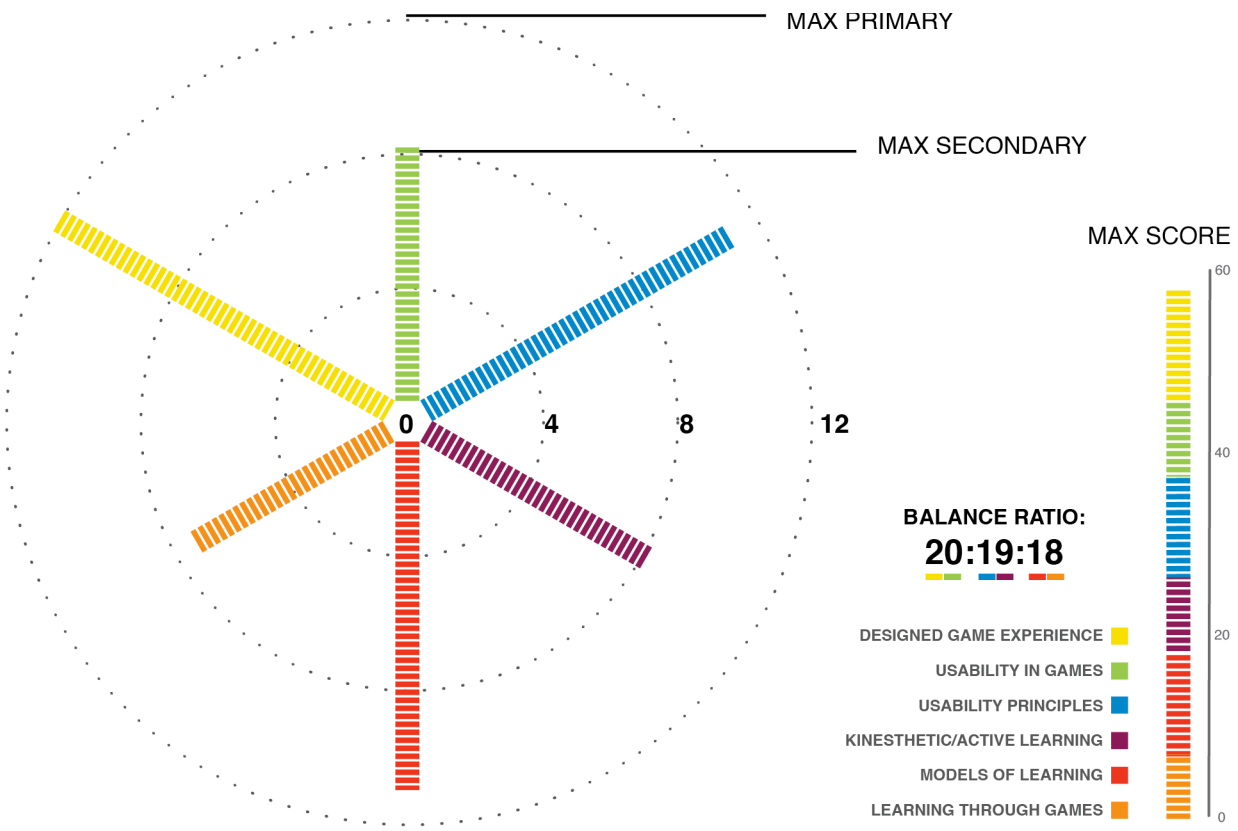
GAME SUMMARY Players assume the role of Roxxi, a nanobot charged with fending of cancer in the bodies of several cancer patients across the U.S. Roxxi is a new generation nanobot who must learn how to administer the correct medications to help kill off certain types of cancer cells in order to save patients' lives.

TABLE 5.2, Re-Mission Evaluation

	0	1	2	3	4
1. Goals + Limits	☐	☐	☐	☐	☑
2. Challenge + Accommodation	☐	☐	☐	☐	☑
3. Facilitate Flow	☐	☐	☐	☐	☑
4. Agency + Engagement	☐	☐	☐	☐	☑
5. Culture + Collective Play	☐	☐	☐	☐	☑
6. Intuitive Integration.	☐	☐	☐	☐	☑
7. Communication	☐	☐	☐	☑	☐
8. Custom Content	☐	☐	☐	☐	☑
9. Reasoning + Comprehension	☐	☐	☐	☐	☑
10. Realistic Metaphors for Transfer	☐	☐	☐	☐	☑
11. Problem Solving + Processing	☐	☐	☐	☐	☑
12. Guided Construction	☐	☐	☐	☐	☑
13. Behavior Modeling + Mentorship	☐	☐	☐	☑	☐
14. Flexible Direction	☐	☐	☐	☐	☑
15. Competency + Confidence	☐	☐	☐	☑	☐

Total Score: 57 / 60

FIGURE 5.2, Score Summary for Re-Mission



Re-Mission serves as a second control game. It is a health-focused serious game with demonstrated effectiveness in helping chronically ill players alter health behavior. It was selected because it is regarded as the standard serious games should attempt to achieve in play, learning, and experience. As you can see, it scored well in all categories of the newly proposed model.

Re-Mission demonstrates good learning and play principles. Its greatest strengths were its use of metaphors for transfer and the dynamic between goals and challenges to enhance engagement. The game provided excellent visual and auditory

cues, consistent with the high-tech aesthetic. This made it a more immersive experience. The game required a player to use specific weapons to kill off certain types of cancer cells. It demonstrated that using the right medicines is the only way to kill the cancer, and how treatment fails if it is not administered quickly enough. This created a definite sense of urgency, while also showing how the avatar's actions affected the patient's health levels. The metaphors were very realistic, too, which would make them easy to transfer. Finally, there were several opportunities to achieve different goals related to time, number of hits, accuracy of shot, and task completion. The guiding character also gave quick feedback if the wrong targets were hit.

The weakest aspect of *Re-Mission* was related to usability. Some of the visual feedback systems were unclear. It also took some time to figure out how to maneuver the avatar and to distinguish between different movements. This was made difficult because the character was controlled primarily via keyboard commands that were not clearly integrated into the game. There was not a clear way to repeat a demo, and absence of a "Help" button made it difficult to discover how to execute an action. These were detailed in the user manual, and could be set by navigating to the options section.

Finally, the guiding character (a nanobot called S M T) was sometimes rude or patronizing during demos, which some players may find discouraging. Comments like "If you're too *scared*, I'm sure we can find another Nanobot to replace you…" were used playfully, but they may undermine a player's sense of confidence and competency.

Game 3: Carb Counting with Lenny the Lion

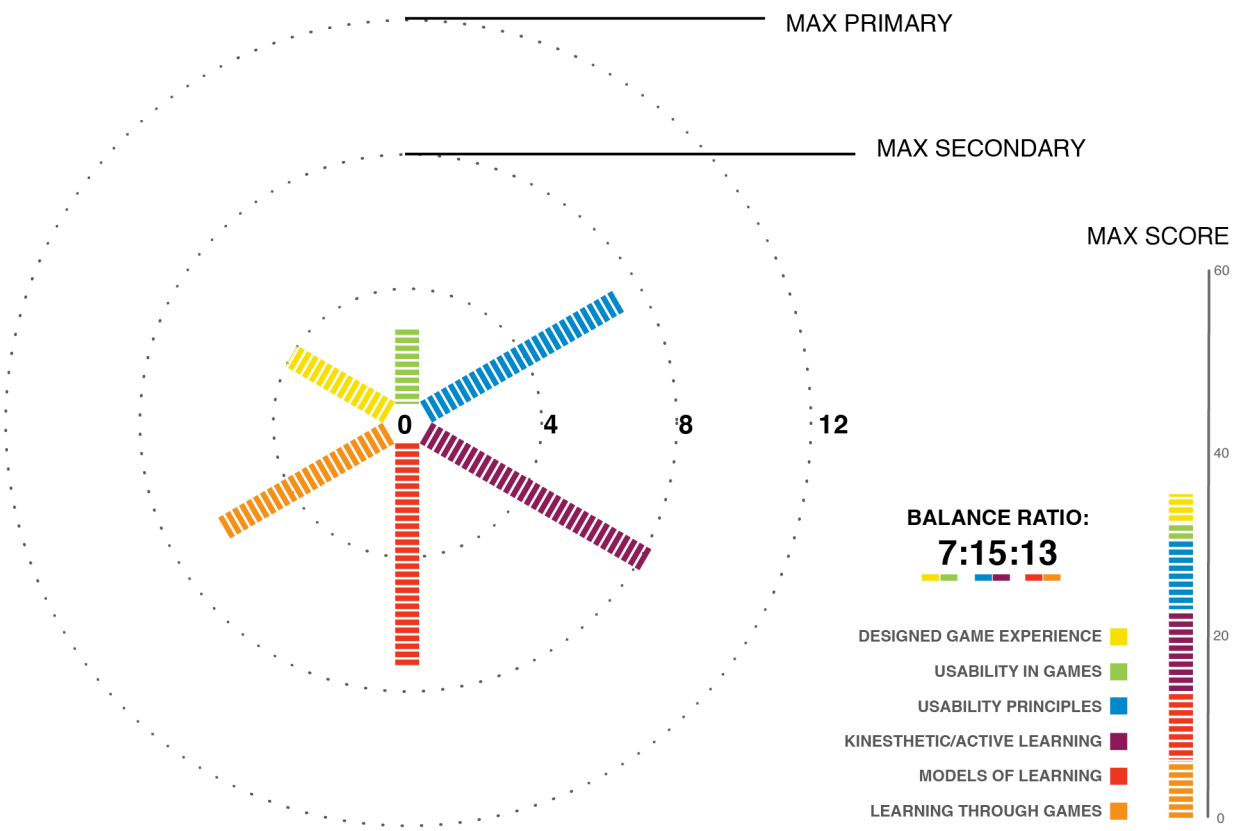
GAME SUMMARY *Carb Counting with Lenny the Lion* is an app divided into two components—Lenny's Food Guide and games. The Food Guide is a photo-based database of foods sorted by food category. Users tap on images to reveal the portion size and number of carbohydrates of each food. Games built into the app tests players in various ways on this information.

TABLE 5.3, Carb Counting with Lenny the Lion Evaluation

	0	1	2	3	4
1. Goals + Limits	☐	☐	☑	☐	☐
2. Challenge + Accommodation	☐	☑	☐	☐	☐
3. Facilitate Flow	☐	☑	☐	☐	☐
4. Agency + Engagement	☐	☐	☑	☐	☐
5. Culture + Collective Play	☐	☑	☐	☐	☐
6. Intuitive Integration.	☐	☐	☑	☐	☐
7. Communication	☐	☐	☐	☐	☑
8. Custom Content	☐	☑	☐	☐	☐
9. Reasoning + Comprehension	☐	☐	☐	☐	☑
10. Realistic Metaphors for Transfer	☐	☐	☐	☐	☑
11. Problem Solving + Processing	☐	☐	☐	☑	☐
12. Guided Construction	☐	☐	☑	☐	☐
13. Behavior Modeling + Mentorship	☐	☐	☑	☐	☐
14. Flexible Direction	☐	☐	☑	☐	☐
15. Competency + Confidence	☐	☐	☐	☐	☑

Total Score: 35 / 60

FIGURE 5.3, Score Summary for Carb-Counting with Lenny the Lion



Lenny is a nice tool to learn about counting carbs. Transfer is made easy because the material and objectives have been gamified. No parallels are necessary because play has not been integrated with the information, but used as a reward. As a result, the game is less engaging. Despite Lenny's having diabetes, it teaches players little through modeling, culture, or exploration. Challenges and goals are relatively simple, and players have few options. This does not promise to engage players for long.

There are four total mini-games in the app. These include "Carb or No Carb?", "Compare the Carbs", and "Guess the Carbs." One of the mini-games requires players to build their own meal with a certain number of carbohydrates, while another simply

requires the player to guess if the food item shown has carbs at all. The difference in games is incrementally challenging, but not in the way other games are. They are closer to the skill and drill methods used in everyday education.

What the app *does* do well is give users a chance to apply new knowledge while delivering clear, immediate feedback. This may not promote behavioral change, but it will encourage players and promote a sense of confidence in dosing insulin in response to dietary intake.

Game 4: Shreddin' Diabetes

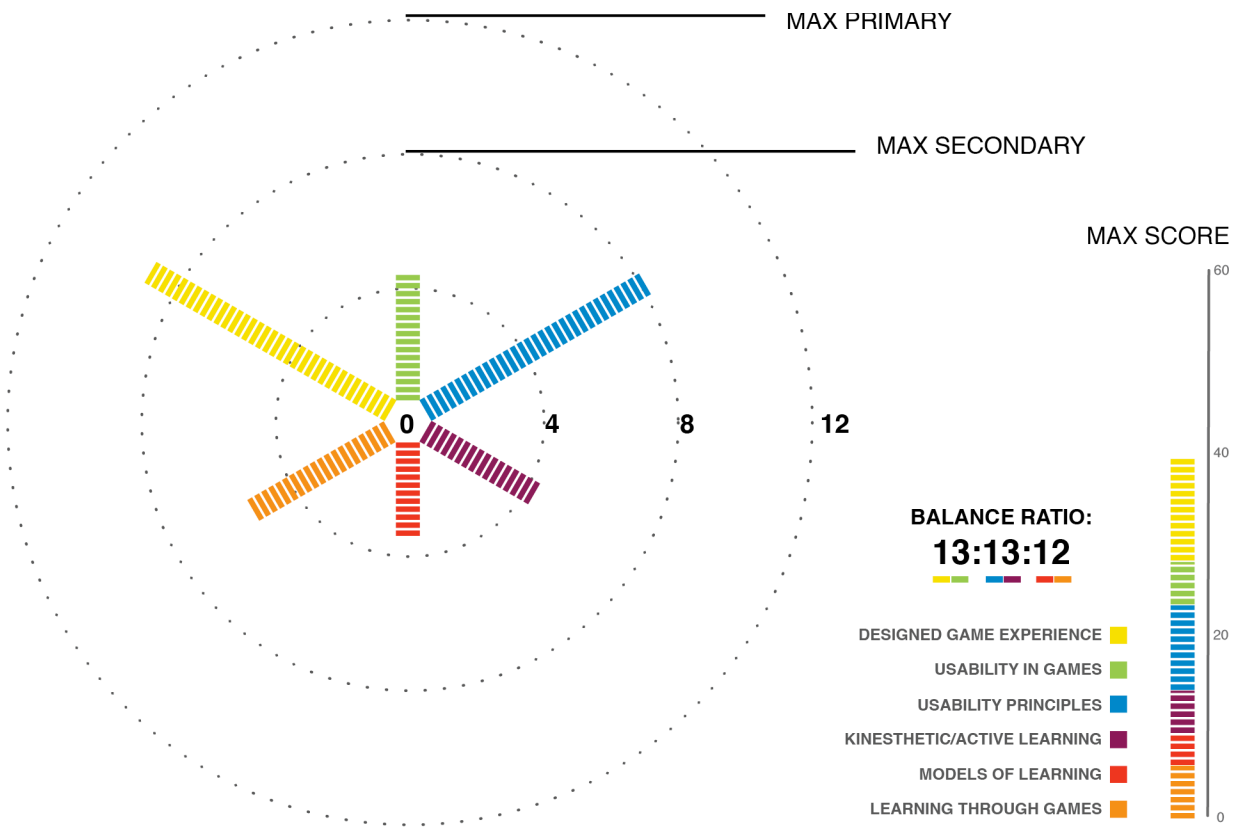
GAME SUMMARY *Shreddin' Diabetes* is an edutainment title that requires players to acquire food energy and maintain good glucose levels as they navigate their avatars down a snowboarding slope.

TABLE 5.4, Shreddin' Diabetes Evaluation

	0	1	2	3	4
1. Goals + Limits	☐	☐	☐	☑	☐
2. Challenge + Accommodation	☐	☐	☐	☑	☐
3. Facilitate Flow	☐	☐	☐	☑	☐
4. Agency + Engagement	☐	☐	☐	☑	☐
5. Culture + Collective Play	☐	☑	☐	☐	☐
6. Intuitive Integration.	☐	☐	☑	☐	☐
7. Communication	☐	☐	☐	☐	☑
8. Custom Content	☐	☐	☑	☐	☐
9. Reasoning + Comprehension	☐	☐	☐	☑	☐
10. Realistic Metaphors for Transfer	☐	☐	☑	☐	☐
11. Problem Solving + Processing	☐	☐	☐	☑	☐
12. Guided Construction	☐	☐	☐	☑	☐
13. Behavior Modeling + Mentorship	☐	☐	☑	☐	☐
14. Flexible Direction	☐	☑	☐	☐	☐
15. Competency + Confidence	☐	☐	☐	☑	☐

Total Score: 38 / 60

FIGURE 5.4, Score Summary for Shreddin' Diabetes



One problem presented by this game is that it was not necessarily designed for extended engagement, something Squire and Gee say is essential to a good game experience. *Shreddin' Diabetes* is a single-player sports game with no social interaction, virtually or otherwise, to guide and inform a player's knowledge construction.

While there is sufficient feedback for maneuvers or errors, it fails to integrate play and learning in several areas of the game. Players were prompted to answer diabetes-related trivia after each checkpoint along the slope. They were required to answer before continuing the challenge. The questions were more like general diabetes trivia, having little to do with the nutritional themes of the game. The game did a better job of

showing the relationship between food and exercise. There was little incentive to consider this relationship beyond a simple food-as-fuel concept—some types of foods (like cake and juice) would boost levels rapidly, while others (like fruit or protein) would give the player small boosts in blood glucose. There was good feedback when levels were too high or too low, but none of this was addressed in post-challenge debriefing.

The game was fun, and it did allow players to re-attempt the two available slopes as many times as they would like. Players were allowed to choose an avatar and a level of difficulty, too, which is a very important part of gameplay. Perhaps the greatest disconnect was in the game's language. Similar to the questions embedded haphazardly throughout each slope, some of the terms used for maneuvers like the "Glucose Grind" and "A1c Air" seem a little forced. The title of one of the slopes—*Diabetes Downhill*—also seemed inappropriate.

Game 5: The Diabetic Dog

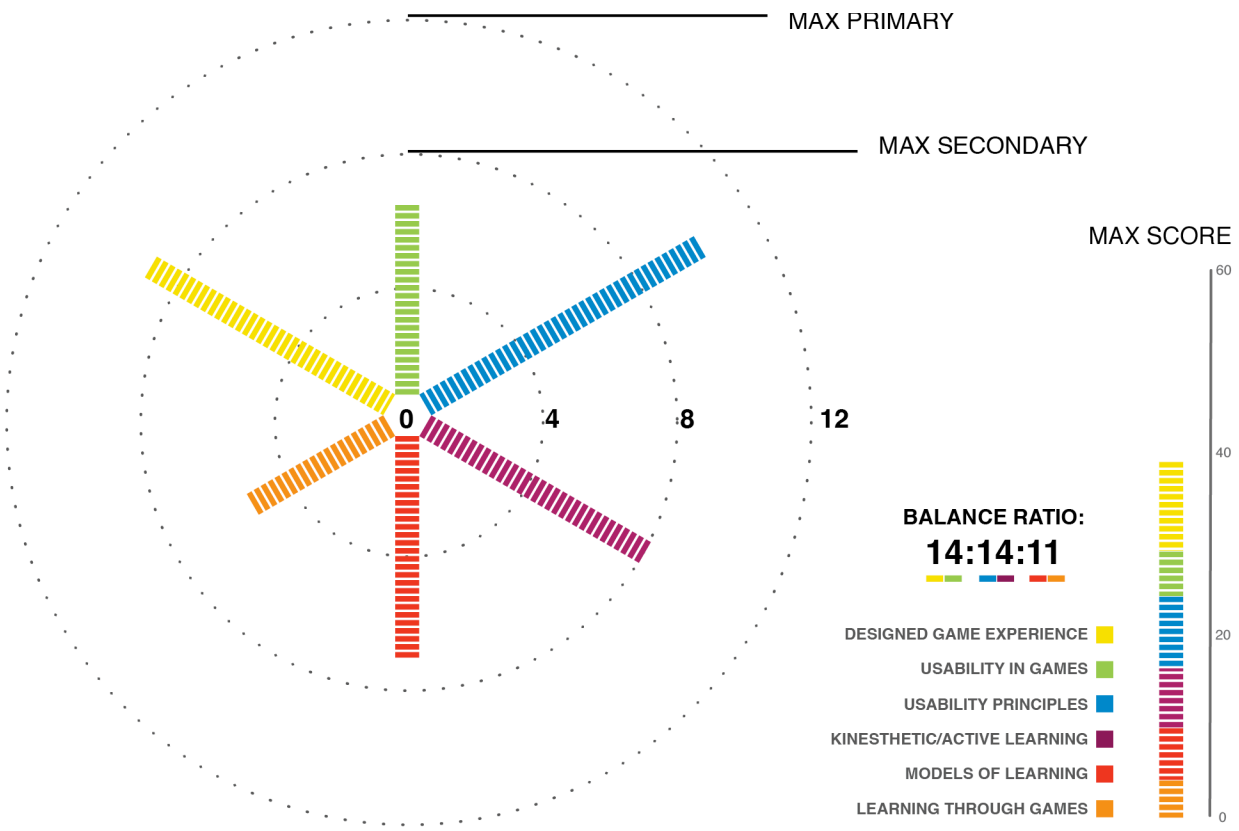
GAME SUMMARY *The Diabetic Dog* is classified as a health-focused serious game. Players care for a puppy with Type 1 diabetes, giving the pet meals, medication, and exercise. They must balance each to keep the dog's glucose levels in target range, or else the dog gets sick.

TABLE 5.5, The Diabetic Dog Evaluation

	0	1	2	3	4
1. Goals + Limits	☐	☐	☐	☑	☐
2. Challenge + Accommodation	☐	☐	☐	☑	☐
3. Facilitate Flow	☐	☐	☐	☑	☐
4. Agency + Engagement	☐	☐	☐	☑	☐
5. Culture + Collective Play	☐	☐	☑	☐	☐
6. Intuitive Integration.	☐	☐	☑	☐	☐
7. Communication	☐	☐	☐	☑	☐
8. Custom Content	☐	☐	☐	☑	☐
9. Reasoning + Comprehension	☐	☐	☐	☑	☐
10. Realistic Metaphors for Transfer	☐	☐	☐	☑	☐
11. Problem Solving + Processing	☐	☐	☐	☑	☐
12. Guided Construction	☐	☐	☑	☐	☐
13. Behavior Modeling + Mentorship	☐	☑	☐	☐	☐
14. Flexible Direction	☐	☐	☑	☐	☐
15. Competency + Confidence	☐	☐	☐	☑	☐

Total Score: 39 / 60

FIGURE 5.5, Score Summary for The Diabetic Dog

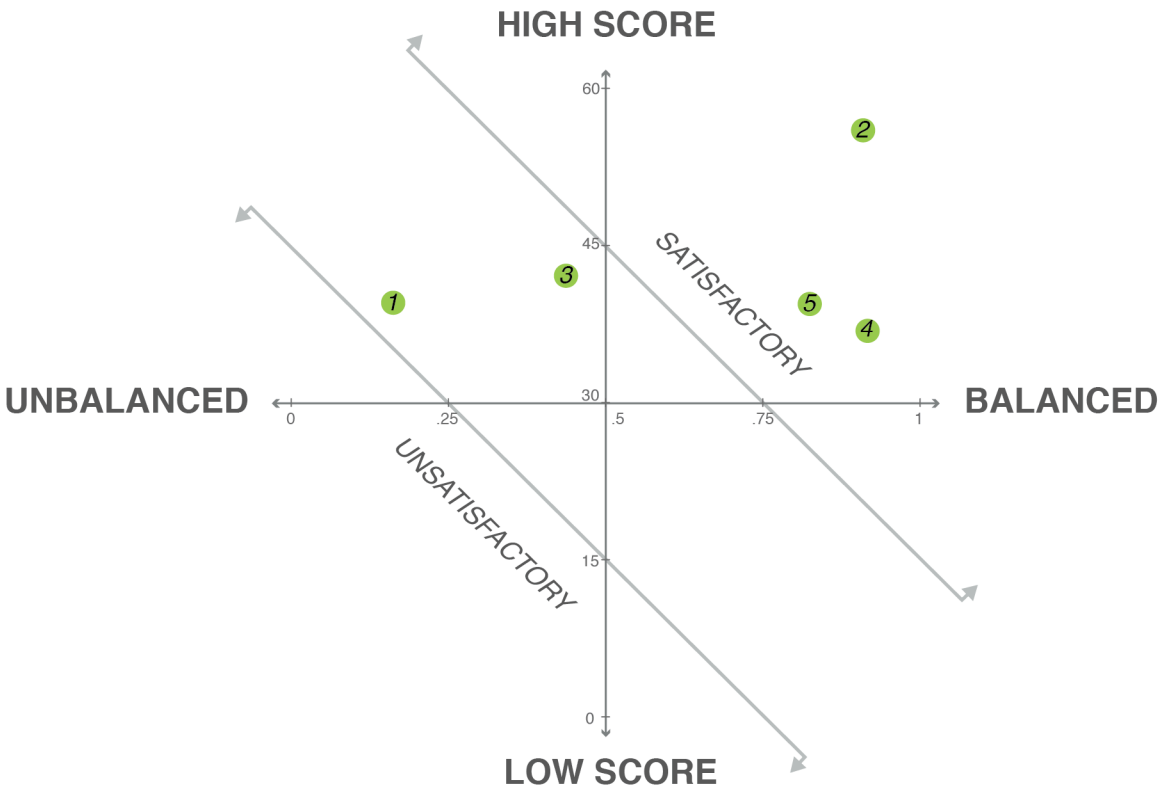


The Diabetic Dog is a simple game that shows how diet, exercise, and insulin work together to affect blood glucose levels. Although players' avatars don't take the medications themselves, they are able to make choices and observe the outcomes of those choices. If the dog gets too much insulin or not enough food, glucose levels plummet. If the dog gets too much food and not enough insulin, they skyrocket. This scenario is true to diabetes care, suggesting that it would be easily transferred. The dog's behavior when it is well and expressions when it is ill elicit a sense of empathy from players. The better the player takes care of the dog, the more play money they

earn to care for the dog. The game's emphasis on moving forward after poor performance is also a positive factor in the game.

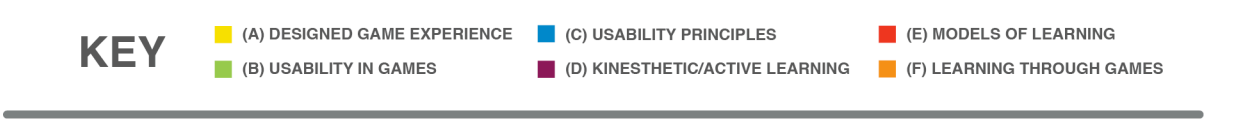
There were several aspects of the game that could benefit from improvement. Firstly, there is no social interaction except with the dog. Coupled with the fact that the game is highly repetitive, some players may find it too simple and may not be compelled to play again. The feedback and communication systems within the game are also somewhat disconnected. For example, instructions are primarily textual. There is a lot of reading with a lot of language younger players may not understand. This preceded gameplay, but there was little feedback from the pet shop owner on how to improve. More sensory feedback, especially audio feedback, may improve the game. Finally, some aspects of the interface were not functional. Save and return buttons, for example, did not respond to user input. Ones that did respond, did not provide the player with activational or behavioral feedback, which may be a source of confusion or frustration.

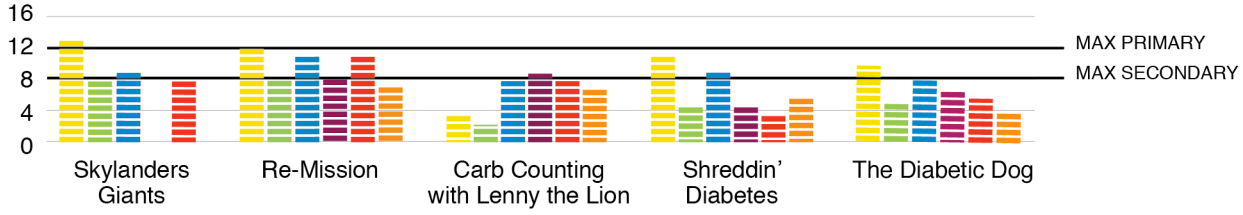
FIGURE 5.6, Summary of Scores



	A	B	Sum1	C	D	Sum2	E	F	Sum3	Balance Score	Total Score
1. Skylanders Giants	12	8	20	11	0	11	0	7	7	.19	38
2. Re-Mission	12	8	20	12	7	19	11	7	18	.86	57
3. Carb Counting with Lenny	4	3	7	7	8	15	7	6	13	.4	35
4. Shreddin' Diabetes	9	4	13	8	5	13	8	4	12	.92	38
5. The Diabetic Dog	9	5	14	8	6	14	6	5	11	.79	39

90th percentile or above is "Excellent" 76th percentile or above is "Satisfactory" 25th percentile or below is "Unsatisfactory"





Chapter 6. CONCLUSION

6.1. Limitations, Considerations, Moving Forward

A good game is immersive, engaging, and motivational. It pushes the player to push the limits of his or her ability, and to expand knowledge and experiences. Above all, a good game is fun. In designing health-focused serious games, these things must be carefully balanced with health learning objectives. Careful analysis of existing models and evaluation of serious games with the new proposed model indicate that social interaction also plays an important part of high quality play and learning experiences. Finally, games are strengthened when objectives are carefully mapped. This is especially true of health-focused serious games, which rely on mapping to transfer specific health behaviors.

The primary goal of this thesis was to create and propose a new, more balanced model for designing health-focused serious games. Analysis of a variety of games, including commercial, educational, and edutainment games has shown that the proposed model may provide a feasible framework for guiding the design of more engaging health-focused serious games. The commercial game (*Skylanders Giants*) scored well in all areas except those specific to health-focused serious games. In contrast, *Re-Mission*, a highly successful and popular health-focused serious game scored very well.

Preliminary testing of the model in evaluating different types of health-focused games also indicates its potential for identifying weaknesses in current health-focused serious games and differentiating them from commercial, purely educational, and

edutainment titles. For example, neither the edutainment nor the educational games scored well, indicating that the proposed model is successful in identifying games that do not adequately balance gameplay, learning, and usability principles.

The Diabetic Dog, the health-focused serious game specific to the diabetes domain, has a much higher balance score than both *Skylanders Giants* and *Carb Counting with Lenny the Lion,* however it did not score much higher than the other two diabetes games in terms of its overall score. Lack of incremental difficulty and social interaction, for example, emerge as possible problems in this game's design. Evaluation of this game with the proposed model demonstrates the model's ability to pinpoint areas of a game that may benefit from further development.

As a proposed model, it is rudimentary. To determine potential success of the model in guiding and evaluating game design, this study warrants further testing, beginning with application by other professionals and a more thorough examination of the model's potential for improving games throughout the game design process. The model should be applied by game developers, health educators, and UX experts who have completed the games for more holistic evaluation. It should also be applied to games that have already examined the relationship between play and positive health behavior. This will help fine tune the model before it is tested and implemented in the game design process.

Games generally go through three checkpoints before being play tested. This was not possible for this stage of development, however the proposed model should be used in each stage of development for future testing to determine whether it will keep

the game balanced throughout the process. Finally, it will be critical to use the model in development of a new game. A truly successful model must produce a game with demonstrated transfer such as what was observed with *Re-Mission*. Therefore, the game must be tested to determine its ability to promote behavior-changing games.

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