

Strategic Design: Breaking Mental Models Initiates Learning in Video Games

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Abstract. An important part of all digital design is effective communication with users. Video game designers, compared to other types of digital designers, have much that they need to communicate within games. As a game progresses, there are often more incrementally challenging mechanics for the player to encounter and experience. By briefly explaining the more traditional methods of educating game players, I will explain how game designers can draw from user experience frameworks to improve gameplay by teaching players in both subtle and dramatic ways with the use of mental models. Perhaps most commonly, mental models have been used to describe and analyze user satisfaction, particularly among digital technologies such as websites. Although there are some key similarities between these types of technologies and video games, significant differences do emerge, although many parallels can still be drawn. I will first explain how video game designers can strategically utilize the lessons learned from previous design researchers. Then, I will explain how and when these models should be broken. By drawing on expectancy violation theory and game design strategies, I argue that purposely violating a player's mental models can prime the player for learning in order to expand his understanding of the game world. After several case studies, I will then provide guidance to game designers who want to implement a disruptive mental model approach to educating players.

Keywords: Mental model · Game design · Expectancy violation theory

1 Designing to Communicate

Every video game designer has a challenge of effectively communicating with the user. When a user plays a game for the first time there can be a lot to learn. Every game has mechanics that need to be understood, and, depending on the game, a story will be in place that gives the user a greater understanding of the universe the player character inhabits. Compared to other forms of digital content, the amount of information available to learn, understand, and eventually utilize can be overwhelming. Game designers strive to communicate the intricacies of the game universe in a way that is efficient enough that the player can enjoy the game and not be frustrated or confused about how to play, but also is not boring or disruptive to gameplay.

Throughout the history of video games, many teaching methodologies have been applied to situations where the user needs to learn something new. Neither Pong, arguably the very first video game, nor Super Mario Bros, perhaps the first widely known video game in the traditional sense, spent any time explaining different mechanics [1]. Everything the user learns in Super Mario Bros is through experimentation. For example, the first section of the first level teaches the user that moving right is the primary direction because there is no other direction the game will allow the character to go. It teaches the player to jump by introducing a mushroom shaped enemy creature that kills the player's character on contact with no other way to avoid it. With the ability to jump, the player learns that hitting boxes with question marks on them gives the player coins. Each new game mechanic is taught passively and builds upon what the player has clearly already learned.

Modern high profile video games, generally, have taken the approach that people who play video games need to have their hands held and led through the game. Every action or experience is told to the user through voice over or a pop-up text box. The concept of teaching through intentional design rather than force feeding the user has not been a common practice for many years. With the rise of independent developers and the growing understanding of user experience, the game industry has recently seen a variety of design experimentations. For example, *Papers Please* and *Her Story* both focus on allowing the user to sift through documents or other types of evidence to determine the course of the game without any need for traditional character movement. This type of creativity is encouraging for the future of video games.

By understanding how users learn and absorb information during gameplay, game developers can design games in a way that improves players' experiences. Recently, designers have looked to psychological principles to improve user experience. For example, by understanding player motivation a designer can create a more engaging game, or by understanding what makes a player emotionally connect to a character, a designer can create a more impactful story [2–4]. In a similar fashion, psychology and education can provide designers with tools on how to better present information about the game's universe in a way that is purposeful—either in a way that conforms to what the player expects, or surprises the player with something unexpected.

Psychologists have documented how finicky human attention, observation, perception, and memory can be. For example, the alarming rates of false eye witness identification are well known. In simulated crime research, some studies resulted in only false identification only a few percent of the time, but in other studies the false identification rate was greater than 90% [5]. During 1996 a study was done on exonerated individuals. The study consisted of 40 convicted individuals that were exonerated by DNA evidence—36 of these “involved eyewitness identification evidence in which one or more eyewitnesses falsely identified the person. One person was identified by five separate eyewitnesses” [6]. Researchers have not figured out *exactly* why humans sometimes think they see people that they do not, but being aware of the vulnerabilities of human observation is the first step to designing to communicate. Similar problems of perception can befall a player in a game world. Once a player has established a basic understanding of how a game works, the user becomes less attuned to all the facets of the game. The player's thoughts concentrate on the tasks at hand to win the game or solve the next puzzle. This phenomenon was best

illustrated in Simons and Chabris 1999 experiment “gorilla.” Subjects had to watch a video in which two teams of people, three wearing black shirts three wearing white shirts, were moving around and passing basketballs. The subjects had to count basketball passes made by players wearing white shirts. During the video, a person in a black gorilla suit walked into the scene, thumps its chest, and then walked off the scene. The person in the gorilla suit was on the screen for nine seconds. The results showed that most subjects, with their attention focused on counting the basketball passes from the white team, missed seeing the gorilla. This study shows that users, when focused on a task, can miss information developers are trying to convey [7].

It seems to make no sense that a user would fail to see a gorilla; however, if you understand mental models and working memory, it makes perfect sense. A person sets up a model to make sure he or she understand and executes the task. “Gorillas are irrelevant and would displace the task in working memory. So the brain, efficient system that it is, filters out the gorilla so that you can keep counting. Seeing the gorilla would be a mistake. You’d lose count” [8]. Given this study it is not hard to see that learning new information about a video game can easily be ignored while a user is deeply engaged.

A different, but equally important, lesson game designers can learn from psychology relates to how individuals’ ability to learn new information corresponds to their expectations about that new information and their mind state as to whether they believe they already know the information. Many of us remember succumbing to the classic “Can You Follow Directions?” worksheet as a child [9]. This worksheet, although it has many variations, begins by telling the reader to read all the instructions first, and then at the end of the instructions tells the reader to only complete a certain portion of the instructions. Needless to say, the first time many children encounter this type of worksheet, they complete the instructions that the worksheet tells them to skip. When game designers are aware of how individuals may skip full instructions, they can take steps to prevent these types of mishaps.

A game designer should consider the mental state of the player and ensure that any new or important aspects of the game are not introduced in a way that will be overlooked. One way to do this is to intentionally break a user’s mental model.

2 Using Mental Models to Better Understand User State of Mind

A mental model is a psychological representation of what someone believes something is or what someone believes will happen, or, in other words, “Mental models are psychological representations of real, hypothetical, or imaginary situations” [10]. Belief is the important part of this definition, as a mental model is not factual. The person is trying to predict what is to come based on the information that they have. Since mental models are predictions, users can have different mental models of an interaction due to previous experiences. People form mental models as they interact with their environments and reflect on causes and effects [11]. Humans have mental models of nearly everything. For example, an American person’s mental model of a traditional restaurant might entail a process of waiting to be seated, ordering off a menu, and having food

brought out to the table, among other things. Or, for another example, a person could have a mental model of a pizza that includes crust, then sauce, and then cheese - many would be surprised if the pizza came out with the sauce on top of the cheese.

The concept of mental models goes back to 1943 when the Scottish psychologist, Kenneth Craik, suggested that “perception constructs ‘small-scale models’ of reality that are used to anticipate events and to reason” [12, 13]. Psychologists have since used mental models when explaining cognitive development. The term ‘schema’ is now more common in psychology than the term ‘mental model’ although the usages are similar. Piaget, in 1954 defined a schema as the basic building block of intelligent behavior, a way of organizing knowledge. “Young children assimilate new observations to schemas derived from their own actions and experiences” [14]. A more defined understanding of a schema was given in the early 2000’s by Wadsworth, “schemata (the plural of schema) be thought of as ‘index cards’ filed in the brain, each one telling an individual how to identify and react to incoming stimuli or information” [15].

Although the concept of a mental model has been used in psychology since 1943, it was not commonly discussed by software designers until the late 1980s. Don Norman’s book *The Design of Everyday Things*, released in 1988, was one of the first books focused on design that mentioned the term mental model. Software developers and website designers have used Norman’s book as a benchmark ever since.

Software developers and website developers have made it a practice to build on Norman’s design concepts. With the rise in popularity of computers and internet use, the main aspiration for a software developer is to create an intuitive experience for the user. Users will describe an experience as intuitive when a design matches their mental model [16]. Every new user to a website or a piece of software will have expectations, mental models, based on their prior similar experiences. “Given that we all have mental models of interaction – it is a good rule of thumb to assume that wherever possible; users will form their mental models based on interactions with existing applications” [17]. For example, if a user is asked to find a particular product on an e-commerce website, today’s user would expect a search function and might be frustrated if such a function was not available. When developers understand the mental models of an average user, they will be better able to generate quality designs that are pleasant to use.

Utilizing a user’s mental models in the design phase has only recently become a common practice throughout the video game industry. This does not mean that companies had not previously employed mental model design techniques, only that the terminology was not universally used. This could be hard to measure, however, since video game companies rarely shared development strategies in an attempt to retain competitive advantages. It was not until the rise of the independent developers in the mid-2000’s, and the communities that grew with them, that development strategies began to circulate. Independent developers started to share the development process to gain attention from potential users and to learn from other game developers. Around this same time, books and articles started being published regarding the use of psychology in the development of video games.

Similarly, due to the growth of user experience research, video game developers have begun to understand the benefits of studying a typical user’s mental model. One advantage is better-designed games with fewer iterations needed near the end of a

development cycle. Understanding user expectations assists a developer in determining when the game plays smoothly or when a user may become frustrated or confused.

The lessons that have been learned from web and software technology clearly have some application in the video game world as well. For example, by ensuring that default button controls are consistent within the gaming platform (whether specific console, PC, handheld, or mobile device), a gamer is more easily able to both try and enjoy a new game if basic functions work as expected. New users expect certain button control functionality consistencies based on previous experiences. For instance, if the game has a shooting mechanic and is being developed for a Microsoft or Sony console it is a best practice to set the Right Trigger button on the controller as the fire button. The results of changing up button controls may not be as catastrophic as, for example, changing the gas pedal and the break pedal in a new car; however, game developers need to ensure that new users can be quickly drawn into the game. The user already has a lot to learn about the new game, conforming to these basic criteria allows the game to feel more intuitive. The user will have an easier time jumping in and learning the different facets of your game. “Exploiting standard mappings of input to response leverages assumable common knowledge to avoid making the player learn something new. A steering wheel turning a car; a mouse moving a cursor; and the W, A, S, D keys moving an avatar are examples of established cultural standards for control” [18].

Even though there are good reasons for keeping certain default mental models intact, there are also reasons that a game developer should break the mental model of a user - particularly at a time in the game when the developer wants the user to be paying attention.

3 Another Way to Utilize Mental Models: Intentionally Breaking Them

Many times video game users ignore information that is displayed or narrated. At the heart of this problem is modern high profile video game design. A user can get the feeling that the video game is holding the user’s hand by giving a tour of the game rather than allowing the user to explore. The biggest culprit is the use of tutorials in the form of text displayed on the screen. Users tend to skip or ignore information the game tries to force on them in text [19]. By ignoring these forced teaching moments, user’s attempt to simulate the feeling of exploration. However, there are other ways to ensure that users are taught important gameplay information, such as gaining the users attention by breaking their mental models.

Although a user’s initial mental model when beginning a game would be based on their similar, outside, real world experiences, the user develops a mental model of each specific game through reinforcement during play [20]. After enough reinforcement, the mental models evolve from predictions to stronger expectations. At this point, we can look to Social Psychology’s Expectancy Violation Theory to understand how breaking a user’s expectation, or mental model, can create a teaching moment.

“Expectancy violation theory (EVT) was developed by Judee K. Burgoon and several colleagues to predict and explain the impact of unexpected communication behavior” [21]. Burgoon’s research initially focused on the communication that occurs between

individuals when a personal space violation occurs. She explains that unexpected behavior causes “arousal” and “influences communication outcomes,” or in other words, that individuals attempt to explain unexpected behavior [22]. Further study of interpersonal communication has confirmed that “when expectations are violated, there is a heightened awareness which is arousing and distracting. This heightened state causes one to regard another person’s communication more carefully” [23].

Although EVT has mainly been used to describe interpersonal communication, the theory can also be used to describe communication between person and object. Although there are not exactly social norms related to human-object communication, most individuals have mental models surrounding how certain objects should behave and/or communicate. For example, individuals who maintain a router for wifi in their homes, expect that their connectable electronic devices will automatically connect to the internet. They maintain mental models regarding not only that the wifi will connect, but also how quickly they will be able to receive data. When the wifi is working, there is little thought or attention given to the router. It likely sits in a corner collecting dust. However, as soon as the router behaves unexpectedly, such as slowing data download speeds, the individuals begin to pay a significant amount of attention to it as they attempt to figure out why the device is not acting as expected.

These same concepts can be utilized to explain how some interactions between video games and users take place. It is not beyond the pale to consider the user is in communication with the game. For example, when the user presses a button, they are expecting the game to do something, or, in other words, to give the user feedback. When a user first begins a game, the mental model of what is expected has not been fully formed. One could compare this more open state of mind to visiting another country and being unsure what societal norms to expect. An individual may know, to some degree, when he does not know what to expect. When starting new games, users are open to learning new information; the designer does not have as hard of a time teaching the user, as long as teaching is done in small chunks because users can easily be overloaded with information. At the beginning of the game, the user is in a frame of mind to learn new things because the mental models have not yet been fully established. However, as has been discussed, mental models are formed and strengthened with repetition. As mental models are reinforced the user builds an expectancy on how the interactions should take place and begins to act out of habit.

Particularly near the middle or the end of the game, there is a higher chance that the user will not be paying much attention to the gaming environment. Information may be glossed over, especially when presented in the form of text boxes or slow narration, and the user will not commit important information to long-term memory, if the information is acknowledged at all. Do you remember the man in the gorilla suit? However, when expectancy, formed from the mental model, is broken, it will be jarring and cause temporary confusion distracting from what they were trying to achieve. The user now has a focused interest, seeking information on why expectations are not met. The designers have a captive audience to the information the designer is trying to convey.

Jesse Schell, in the book *Art of Game Design*, talks about mental models and magicians. His point is that magicians break a viewer’s mental model in order to complete the magic trick. “The audible gasp that comes from an audience at the culmination of a

magic trick is the sound of their mental models being torn asunder” [24]. A similar effect is happening when breaking the mental model in a video game. Hopefully, if done well, the user will be inspired to seek out information rather than be entirely stunned by an illusion. The aroused user will be more attentive and likely more inspired to actively interact and communicate with the game.

I am not proposing that this is the only or best way to communicate with or teach the user. I am simply suggesting that intentionally breaking a user’s mental model is simply one design methodology to add to the game designer’s toolbox. There are clearly many different styles and ways of learning, and depending on the type of information your user needs to learn, as well as who your learner is, a different methodology might work better. For example, a complicated task that builds on information previously learned might be better suited by using scaffolding instruction, which is a method of teaching that assists the learner only when support is needed for tasks that the learner would not otherwise be able to complete [25].

However, although further research is needed, breaking the user’s mental model likely has several benefits that other forms of instruction do not, particularly when considering the lack of attention some game designers give to methods of learning and the commonplace use of disruptive pop-up text boxes as a method of instruction. For example, breaking a user’s mental model may be able to keep a user in a flow state and teach the player at the same time. A flow state is when skill and difficulty are roughly proportional, and the user becomes immersed in the game. In the 1970s Mihaly Csikszentmihalyi found that the difficulty of a task and the person’s skill result in different cognitive and emotional states. “When skill is too low and the task too hard, people become anxious. Alternatively, if the task is too easy and skill too high, people become bored” [26] (Fig. 1).

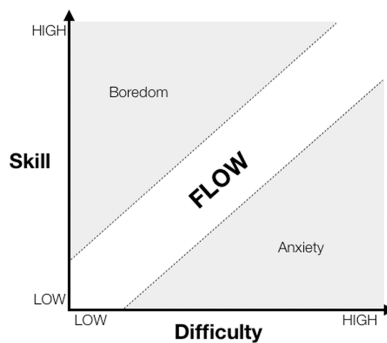


Fig. 1. Flow, boredom, and anxiety as they relate to task difficulty and user skill level. (Source: Baron, S. (2012))

Additionally, by breaking the mental model and encouraging the user to find out why the game is not acting as expected, the user will be more likely to test different functionalities within the established game mechanics and further explore the game world. This should keep the user in a flow state leading to interesting experiences and more enjoyment for the user during play.

A designer might also consider employing multiple instructional methods together by first breaking the user's mental model and thus generating an optimal learning state of the user before further employing another teaching technique. Breaking the user's mental model is an educational technique that can be helpful on its own or in conjunction with other teaching strategies.

4 How Game Designers Can Successfully Apply These Theories

Breaking a user's mental model is not a methodology that can be used every time you want to teach the user something about the game. It should be applied once the user established the mental models that are specific to the experience the game provides.

An excellent way to help the user establish mental models in the beginning of the game is to be aware of the onboarding process. Onboarding is a term the user experience field took from the field of human resources that describes getting a new user (or employee, in HR) up and running. "The onboarding process is a critical step in setting your users up for success with your product" [27]. A common mistake by developers of all disciplines, not just game design, is to overload the user with information during the onboarding process. This leads to the user feeling overwhelmed and frustrated. Celia Hodent, the Director of User Experience at Epic Games, recommends that only small amounts of information be taught at one time in order to ensure smoother onboarding. During a lecture at the 2016 Game Developer Conference, Hodent stated, "I suggest you to remember that 3 items to process at the same time is THE MAXIMUM when in learning mode (discovering everything) because new tasks have a much higher cognitive load than familiar or automated ones" [28].

When the time comes to break a mental model, there is a fine line between breaking a mental model in a way that the user maintains engagement versus user disappointment, or worse, user disengagement [29]. Proper implementation will happen after testing with users as well as quality assurance testers. The feedback received will give great insights on how the user interprets the situation when the mental model is broken. It may require a few iterations to ensure that the user maintains a motivated attitude.

In order to determine when and if breaking the user's mental model will be an effective development strategy for communicating new information, the designer must first understand his or her own mental models about how the game operates, given that the design itself was built off the designer's own mental models. The designer's mental models may or may not be closely aligned with the mental model's of the game's eventual users. Both the mental models of the designer and of the users are built from interacting with the game and reliance on prior experiences [30].

Understand the Game's Genre and Pick a Target Audience. Before a designer can attempt to accurately predict the mental models that a user will bring to the game, and those that the user will develop within the game, the designer should first consider the genre of the game and the genre's target demographic. Video game genres can be very nuanced, which leads to a very long list of different genre types. In the book, *The Medium of the Video Game*, Mark Wolf, lists 42 categories of video game genres [31]. Some of the most common genres of video games include: Action, Fighting, Platformers, Puzzle,

Racing, Strategy, Sports, and Shooter [32]. Keep in mind that just because a genre is chosen does not mean that the designer should copy and paste interactions, “it must be noted that players of games—that is, their audience—are not necessarily satisfied with the same generic conventions being endlessly repeated. The expectation is that the stability of genre will be tempered by innovation; this innovation may be technical, not necessarily stylistic” [33]. For a designer, a video game genre is a roadmap, not a blueprint. However, without understanding the breadth and scope of the genre of your game, a designer will not be able to properly understand what mental models players will be bringing to the game from prior experience.

Even within a singular genre a demographic-or a target audience-should be established. The International Academy of Design & Technology blog suggests that, in order to identify and understand the demographic of your audience, a game designer should consider questions such as, “Who will enjoy my game, what other types of games do these gamers enjoy, and what kinds of challenges or narratives do they like?” [34]. Another aspect to consider is the segment of the demographic that the game aims to target. Jason VandenBerghe, a Creative Director at Ubisoft, during a presentation at the 2016 Game Developers Conference, talks about the concept of taste mapping. Customers will have different reasons for playing a game. Those reasons can end up graphed in a bell curve starting with “Care a lot” to “Meh.” The curve represents the users likely investment in your game (Fig. 2).

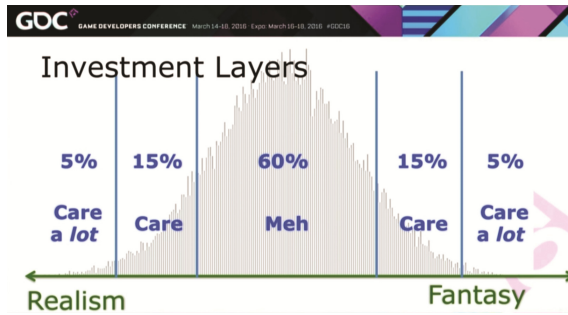


Fig. 2. Investment layers slide from 2016 game developers conference talk by Jason VandenBerghe

VandenBerghe took the investment layers graph and applied it to a taste map with the same realism/fantasy scale but also added the reasons building things versus exploring. A taste map can be made with any type of reasons a user may play a game. Another example of a taste map may show mechanics vs context and combat vs cooperative play. The 5% of people that are really invested will be advocates of the game and do what they can to talk about the game to other users. This segment of high investment users are unfortunately a low percentage of the total user population. The middle of the chart show the users with low investment in certain aspects, but there are a lot of users. Choosing which segment of the demographic to design for can be a challenge [35] (Fig. 3).

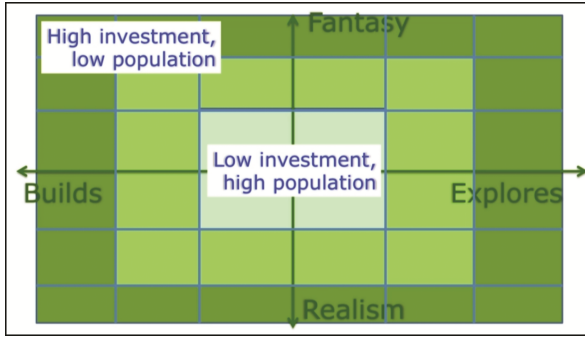


Fig. 3. Taste mapping slide from 2016 game developers conference talk by Jason VandenBerghe

Create a Persona of a Typical User. Once the genre and target audience has been established, the designer should create a persona of a typical user. A persona is a fictional character designed to represent a typical user. “Personas not only make the target audience more real to designers and engineers, they also ensure that requirements are prioritized to specifically meet the needs of high-value users” [36]. Personas should be created at the beginning of a project because they can inform game functionality, help uncover gaps, or highlight new opportunities [37]. It is important to understand that a persona acts as the voice of the user. Applying a persona helps the developers understand the user’s context, pain points, behaviors, goals, motivations, needs, and attitudes. Additionally, personas can be used to validate or disprove design decisions, vet and prioritize feature requests, and inspire ideation [38].

Personas are ideal for determining the mental models of a typical user. When a game developer understands a user’s motivations and strategies, which are revealed through the creation of a persona, designing teaching moments become clearer [29]. Often multiple personas are created; common choices are to create a novice and an expert user persona. There is always a design balance regarding expert users and novice users. If too much time is spent explaining game mechanics, the expert users will feel bored and uninterested. If not enough information is given, the novice players will become frustrated. The term expert does not mean users that have already played the game and are now proficient. In this case, the term expert is used for new players that have strong expertise in the genre. “When a productivity interface exploits the existing skills of users, even those who are new to the interface can perform tasks rapidly and with few errors” [39]. A small example of a common design theme among genres is the use of the exclamation marks and question marks over the head of a non-player character (NPC) in role-playing games.

An expert user in the genre will instantly know that an NPC with an exclamation mark will have valuable information and or give the user a quest. If a user sees an NPC with a question mark, then the user has satisfied the requirements to complete a given quest. Speaking with the NPC with a question mark will allow the user to earn rewards for the completion of the quest (Fig. 4). As mentioned, this was a small example and is not implied that it would be hard for a novice user to learn the meaning of the exclamation marks and question marks. A series of steps can be taken to implement the methodology of breaking a user’s mental model within a video game.



Fig. 4. Images from the game World of Warcraft

Figure Out the Mental Models That Will Be Created When the User Plays the Game. Every video game will create a user experience that impacts the development of its users' mental models. The designer cannot attempt to break a user's mental model if the basic mental models of the game have not been well established or if the developer has not taken the time to understand how the game experience is impacting the players. It will, of course, be impossible to know each potential user's exact mental models, as each person experiences the world differently, but, by utilizing personas and paying attention to the details of the game, the designer can likely predict the most common mental models with some accuracy.

Mental models are commonly established when the user learns the game mechanics. Super Mario Bros. establishes the mental model that the player character runs and jumps. Game mechanics establish the rules of the game and actions that can be performed. "These actions are most often related to character movement, vulnerability to threat, sense knowledge, and interaction (e.g., speaking, shooting, fighting). Each of these character mechanics has parameters that delimit a particular ability" [40].

Determine the Information That You Want To Teach and Disrupt the User's Mental Model. Very often a video game will need to teach a user something in the middle or near the end of the game, perhaps a new ability, a new location that is now available, or a new enemy that appears. Understanding what information is required to teach the user during the design phase will allow more creative solutions to breaking the users mental model. To effectively teach important information, the designer can strategically break the user's mental models and establish a captive audience.

Once a mental model is generated, the designers will have information regarding the best places to implement the intentional use of breaking the user's mental model. There are at least two things the designer must consider when implanting this type of learning strategy: first, how is this new information entirely different from the mental models already established, and second, how can the game cause the player to try or utilize this new information? If the answers to these questions can be clearly answered, hopefully, the game will

break the user’s mental model, creating a teaching moment where the user will be more likely to retain the information in long term memory and have better engagement.

A few video games that have broken the mental model are listed below. These examples can be used as inspiration for when to apply the method of breaking the mental model to teach.

5 Breaking Mental Models: Case Studies of an Effective Practice

Intentionally using the method of breaking a user’s mental model for teaching purposes is not widely used in the video game industry. However, there have been examples of video games that employ the technique, whether meaningful or not.

Super Meat Boy. Developed by independent developers Team Meat, Super Meat Boy is a challenging 2D video game in the platformer genre (Fig. 5). At the beginning of the game, the user builds a mental model around the jump mechanic. The user jumps to avoid saw blades and jumps from one platform to another avoiding falling into large gaps. When the creators of Super Meat Boy want to teach the user the “wall climb” mechanic, they load the user into a level with only a large wall on the right side of the screen; no platforms are available in range to jump on. The lack of platforms in the level breaks the user’s mental model of the jump mechanic, forcing the player to solve a problem not yet encountered.



Fig. 5. Gameplay screenshot of Super Meat Boy.

Before this point in the game, users understood that to get around tall obstacles, they needed to jump on platforms in a stair-step motion. With the jump mechanic mental

model broken, the user has naturally become willing to learn. During problem-solving, the user will eventually jump onto the large wall on the right side of the screen, in an effort to make use of the jumping mental model already established. Once players jump on the wall. They will notice the ability to “wall climb.”

Uncovering the “wall climb” mechanic and solving the problem of completing the level gives the user a great deal of satisfaction because the user is self-taught. Additionally, because the user was self-taught he will be more likely to apply this teaching moment to long term memory. Being able to recall the ability will be helpful in later levels of the game. If the developers had taken a traditional route to teaching the player about the “wall climb” ability, a text box would have appeared once the player loads into the level, explaining the new mechanic. Users would have either ignored the text box or, at the very least, felt half-hearted about the “wall climb” ability because they would not have experienced a sense of discovery.

Final Fantasy X. Developed by Squaresoft, Final Fantasy X breaks the mental model of how healing and damage dealing effects can be applied (Fig. 6). This section is written based on my experience playing Final Fantasy X. Admittedly, the status effect Zombie could have appeared in previous Final Fantasy games and lovers of this Role Playing Game (RPG) series may have learned of it before Final Fantasy X. At the time, this was my first attempt at a Final Fantasy game, so I am commenting from that perspective. I was fighting the boss Lady Yunalesca, and a status effect Zombie was placed on all of the player characters in my party. I had not encountered the Zombie effect previously in the game and was unsure what to expect. Lady Yunalesca attacked one of my characters and lowered the health to nearly zero. I attempted to heal the character by using a healing potion to save her from death. My mental model of healing was broken when the healing potion dealt damage and killed the character rather than healing. Along with the mental model of healing, my mental model of how to complete a boss battle was now broken. Lady Yunalesca was still able to inflict melee damage, and I needed to figure out different steps to take to keep my characters alive while fighting a boss battle.

Now with full engagement, I was willing to learn all I could about the Zombie effect. Ultimately, I discovered that there are ways to heal a Zombie status effect, using a Holy Water potion or Remedy spell for example. However, during this boss battle, I found out that while inflicted with Zombie, characters would be immune to Instant Death attacks. Lady Yunalesca uses a spell called Mega Death which would kill all of the player characters not affected by Zombie. The developers made sure to show different facets of this one effect during the boss battle.

With my healing mental model broken and more knowledgeable on how the Zombie effect works, I am now inspired to be creative with the Zombie effect in the future. One of the player characters, Auron will eventually have the option to learn the Zombie ability and use it on enemies. Being creative, I found out that I could inflict enemies with Zombie and then use the potion Phoenix Down, which normally resurrects fallen player characters, and instantly kill the infected enemy. A whole new world of possibilities opened up on how I could inflict damage.



Fig. 6. Gameplay screenshot of Final Fantasy X.

World of Goo. Developed by 2D Boy, World of Goo is a physics-based puzzle game in which players construct structurally sound platforms out of black balls of goo. The goal is to build “bridge like” structures that can get from one part of the level to another. However, when the user gets to Chapter 4 the mental model is broken regarding the balls of goo and how they work. When loading into Chapter 4 the balls of goo change from the color black to the color green and are accompanied by green square blocks of goo (Fig. 7). Not only does the color change for the balls of goo, but they are no longer used

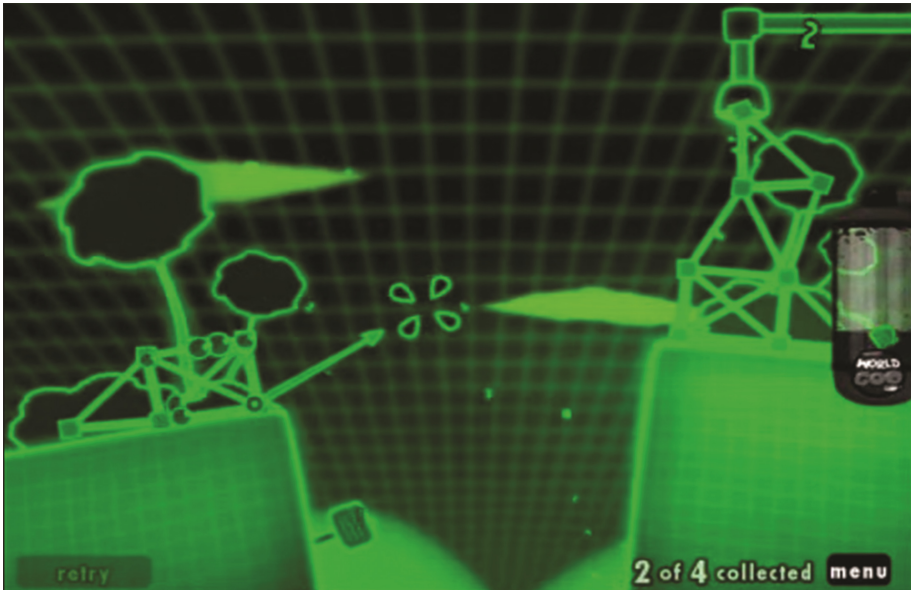


Fig. 7. Gameplay screenshot of World of Goo (Color figure online)

for building structures. Instead, they jump to other formed structures when the user interacts with them. Due to the broken mental model, the user experiments with the new functionality of the balls of goo as well as the green square blocks. After experimentation, the user learns that the green square blocks take the place of the previous balls of goo and are used for constructing structures the green balls of goo can jump on too.

Snapshot. Developed by Retro Affect, Snapshot is a 2D platform game in which the user takes photos of objects and can drop the photographed objects in different parts of the level. The player's mental model of getting over a high platform is taking photos of the objects, mainly boxes, and stacking them up. The goal is to be able to stand on the stacked objects like a step stool in order to jump onto the high platform. The developers took a similar approach to teaching the player a new ability as the designers of Super Meat Boy in this example. The user loads into a level with a high platform, they do not have access to an object that can be stacked. With the mental model broken, the users starts to take a second look at the environment around them to solve the problem.

Snapshot does not have a "wall climb" mechanic like in Super Meat Boy. Instead, the developers are trying to teach the players that elephants will act like trampolines. Walking along the ground at the bottom of the level is an elephant. At first the elephant seems like an interesting artistic asset to make the world appear more real. If users attempt to interact with the elephant, they will notice the trampoline effect and can then get over the high platform (Fig. 8).

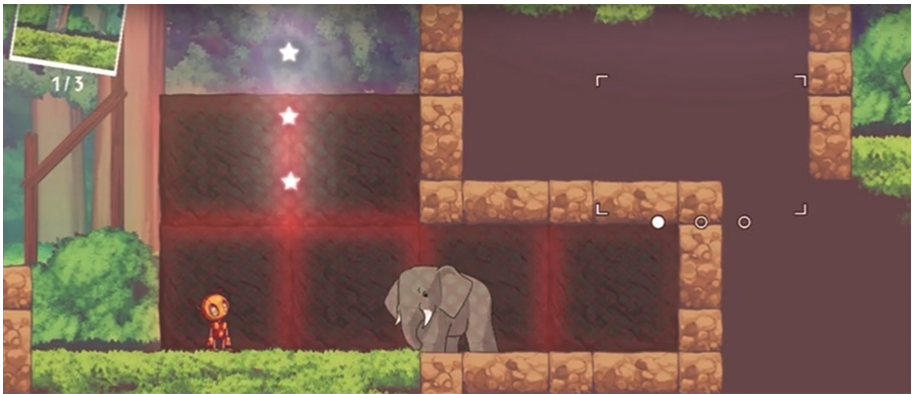


Fig. 8. Gameplay screenshot of Snapshot.

Hearthstone. Developed by Blizzard Entertainment, Hearthstone is an online collectible card game, similar to Magic: the Gathering. Near the end of Hearthstone tutorial is an example of a mental model being broken. Each player has the same set of cards to make a card deck and the rules apply to both users equally. Up until this point, the only way to play was to make decisions based on the cards in the player's hand or the cards that are still on the board from a previous turn.

The developers want to teach the player a new mechanic in which the player character gains a Hero Power. To do this, the user is introduced to the new mechanic by seeing

the hero ability given to the computer opponent first. This different ability draws attention and breaks the mental model of standard gameplay because the players are no longer equal in types of choices to make. The user is paying close attention to how the computer opponent is using the new ability in order to learn how to play against it. Additionally, suspense builds as the user becomes curious if they will get a similar ability. Once the computer opponent uses the Hero Ability to attack the player the turn ends and it is now the user's turn. During this turn, the Hero Ability is applied to the player. The player paid close attention to how the opponent used the ability and will not need much training on how to apply it (Fig. 9).



Fig. 9. Gameplay screenshot of Hearthstone.

Mega Man X. Developed by Capcom, Mega Man X has one of the best examples of breaking the mental model. In the first level, the player is introduced to nearly all the mechanics of the game. The user learns that they have the ability to shoot a weapon, shoot while jumping, wall climb, and some enemies exist with “sweet spots” meaning the weapon can hit only certain areas, otherwise no damage will take place to these enemies. At the end of the first level the player encounters the boss, none of the abilities the player has learned deal damage to the boss character. The user's mental model regarding attacks are broken, and the user starts to feel defeated as the player characters health bar is nearly depleted.

The mental model has been broken since the start of the boss battle. However, near the end of the encounter is when the teaching moment takes place. A friendly nonplayer character (NPC) named Zero appears and uses a charge effect shot on the boss, doing enough damage it causes the boss to escape (Fig. 10). Through this interaction, the player learns that they can charge their shoot ability to use a stronger attack. The game did not have to stop gameplay to teach this ability, and the players learned on their own.



Fig. 10. Gameplay screenshot of Mega Man X.

6 Conclusion

Users have a surplus of video game options in today's market. A user's time has become the most important element to the decision of purchasing a game. Understanding that competition among video game developers is high, it is important to be able to communicate effectively to the users. Developers can turn users into evangelists for their game when a user has an immersive, enjoyable experience. An important factor of immersion is how the user absorbs information and can apply the lessons appropriately. Employing the teaching technique of breaking the user's mental model will ensure that the user is open, in that moment, to learning new things about the world created by the development team.

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