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"The Principles of Videogames"

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Intro

What words or phrases come to your mind when you think of videogames[1]? Do you think of "pause", "lives", "K.O.", "game over", "push start", fun, or "meaningless play"? What about "educational"? I consider videogames to be "educational" and report my findings based from that vantage point. When I speak of "educational" I am not referring to videogames like Math Blaster or Mavis Bacon, or other videogames developed to teach academic concepts. I am referring to the concepts and tropes[2], the *principles* found in videogames. So many people play videogames and for different reasons. I want to peel-back, not just why people play videogames, but what makes a good videogame. The guiding question of this paper is: What makes videogames engaging and how can we use that "*what"* in a secondary mathematics classroom?

Research

In order to discuss videogames we must establish a credibility to even have a discussion. I am not trying to explain and advocate for people (mostly children) to play videogames more often, I am advocating for an understanding of what videogames are and what we can learn from them. To play a videogame means to play the "code of the game," to win means to "interpret a game," and to "interpret a game means to interpret its algorithm" (Wark, 2007). The "code of the game" refers to the technical computer language used to develop the game. A player who can "interpret a game" is a person who understands the instructions and goals presented in a videogame. In order for a player to win or beat a videogame, the player must "interpret" the game and implement the actionable "inputs" that correspond to the videogames "algorithm" of success (Wark, 2007). A simple example is playing Tic-Tac-Toe.

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1 I use the one-word spelling of videogame and not video game because I believe the one-word spelling definitively separates the genre and culture of videogames from simply being a classification of a type of game (ie. Puzzle games, dice games, etc.)

2 Tropes in videogames refer to 'clichés' or common themes and devices found in videogames. Such as hidden items, bonus

When playing Tic-Tac-Toe we “interpret” the game as a turn-based game of players using X's and O's to designate actions or “inputs.” To win at Tic-Tac-Toe we understand the “algorithm” of success as getting three of the designated “inputs” in-a-row, and we recognize the center position of the game to be the most desired position in the game. To win at Tic-Tac-Toe, a player must make a mistake or mis-“interprets” the current “algorithm” of the game, and the other player must recognize that mistake and capitalize. In videogames we must “interpret” the instructions and goals of the game, while using the controller as an “input” as a response of understanding the “algorithm” of success. If I need to shoot an alien, I push B. If I need to jump, I push X. If I need to use the bathroom or take a break, I push START.

Why would someone play Tic-Tac-Toe? Is it because it is fun? Prensky (2001) asserts that the “ 'fun', we derive from games is the principle source of what make us return to do them again and again.” In fact, much like any other activity, the more we play a game, the better we tend to become at playing that game. The better we get, “the easier the [game] becomes, and the more goals we can achieve.” (Prensky, 2001). James Paul Gee (2008) asserts that “the game encourages [players] to think of [themselves] as an active problem solver, one who persists in trying to solve problems even after making mistakes.” Why is that? What principle(s) prompts a player to try a game over-and-over again? If we could answer that question, imagine what the translation of that answer into a secondary mathematics classroom would look like.

Background

I have a confession to make before I talk about the specific set of videogames I will use and refer to for this paper: I am a gamer. I have been playing videogames since I can remember. I remember being 5 years old and going to my cousin's house to play his Nintendo Entertainment System (NES). We would take turns playing Ghouls 'N Ghost, team-up playing Chip 'N Dale: Rescue Rangers, and

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bosses, and items that a character can find that actually harmful (the purple mushroom in Nintendo's Mario games).

playing against each other in Off Road for several years. I would eventually have my own videogame system in 1993 when my dad bought me the Super Nintendo Entertainment System (SNES). This made me a fourth-generation (4th Gen) gamer[3]. Since my childhood, I have amassed 50 different SNES games. My SNES collection represents 25 different videogame developers (12 of my games were developed by Nintendo), and 23 of my games are two or more players. Aside from my SNES (released in 1992), I have had three different types of hand-held videogame systems: Nintendo Gameboy Pocket (released in 1996) and Color, SNK Neo Geo Pocket Color (released in 1999), and multiple Tiger Electronic handhelds (X-Men and Mortal Kombat). By the time I was in 8th grade, I saved-up money from a Sony Playstation (the PS was released in 1994), and I was given a PS2 (released in 2000) for my birthday in 10th grade. I haven't bought a Next-Gen (PS3, Microsoft Xbox, Nintendo Wii) system since my PS2. While I have played many different videogames on the Next-Gen systems, I have decided not to buy any of these systems because of financial and time-constrained reasons. Simply put, I love videogames and consider myself a gamer.

I decided to focus on using my SNES games to conduct and reinforce the research for this paper. I did not make this decision from bias, but from the strengths that these games presented. Not only did I play and beat many of the games I have for the SNES, but I also mastered the “algorithm” for some of these games. As I solidified the principles found in videogames, I used my experience to reflect on how a principle was used in a specific SNES videogame. I also reflected on a few other videogames for different systems. My research has provided me with a different lens to view and interpret many of the videogames I have played and come to love.

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3 Videogame systems are produced and sold in generational timing. This generational timing is not based on the age of the gamers, but the technological advances of the systems being produced. The SNES and SEGA Genesis is considered to be the brand of 4th Gen Videogame systems (possessing 16-bit processors and a wider set of capabilties). The preceding videogame systems include the NES (3rd Gen), Atari (2nd Gen), and the Odyssey (1st Gen).

The Ten Principles

Principle 1: Active & Critical Learning

The Active & Critical Learning Principle is most necessary principle in a videogame. A player is required to actively participate in the videogame, using the controller (or their body with Next-Gen systems), to make progress. A player cannot sit-back and watch a videogame play itself, unless they are watching another player play the game, and view progress like a movie. Many SNES videogames, like Goof Troop and Kirby's Dream Course, use the first level of the game as an introduction into the topography of the game. The player is introduced to the character they will be using in the digital environment and use the controller to learn how that character interacts within that environment. The early levels in a videogame are used to form “generalizations that are fruitful for later cases” (Gee, 2008). If a player learns that a character can jump while in mid-air (a “double-jump”) during the first level, then when that player is presented with a challenge requiring that player to “double-jump”, the player should be practiced enough to succeed.

It may seem intuitive for a videogame to get harder as you play, but harder does not correlate to increased critical play. Some videogames increase difficulty thru the enemies on screen: adding more enemies, and/or increasing the amount of hits it takes to beat an enemy. Some videogames increase difficulty thru level design: making the level longer by expanding it, adding more bottomless pits and dead-ends, and/or adding a new environment like being underwater or in space. Increased critical play is achieved from the different combinations a videogame presents to a player to increase difficulty. I will explore some of the combinations done well later in this paper.

Principle 2: Semiotic Interaction

The Semiotic Interaction Principle is the graphics, sounds, and responses a videogame gives to the player. The SNES presented a lot of Semiotic Interaction. Try comparing Pong with Super Mario World. Pong has a two color scheme, no music, and sound-effects when the ball hits the paddles and walls on the screen. Super Mario World has a vast color scheme, music designed for practically every level in the game, and constant sound-effects from actions displayed on the screen. To put this in perspective, the NES had a 64 color palette and the SNES had a 32,768 color palette. The limitations were in the hardware of the videogame system. The NES limited a character (sprite) to have no more than 4 colors present at a time. The SNES limited a sprite to have no more than 16 colors present at a time (Dualing, 2012). As technology increased, so has the total amount of Semiotic Interactions. The current trend in Next-Gen videogame systems is to make a videogame as realistic as possible; think graphics and whole body Semiotic Input (via Xbox Kinect, Wii, or when you play Rock Band).

Semiotic also represents the context of interacting within the videogame environment. Being in one situation in one videogame may mean something completely different from another videogame. When playing as Mario, the player can go underwater and you have to worry about breathing. When playing as Sonic the Hedgehog the player can go underwater, but must swim into air bubbles so they do not drown. When playing as Michael Jordan in the SNES game Chaos in the Windy City, the player's character dies the moment the water level goes over his head. When playing as Mickey Mouse in the SNES game A Magical Quest, the player needs a specific power-up to go under water in the first place. A player comes to understand how the digital environment interacts with the character(s) in a specific videogame and responds accordingly. In Kirby's Dream Course for SNES, Kirby can survive underwater, but this can be avoided by using a power-up to turn Kirby into an snowman, which turns the water into ice allowing Kirby to glide across. While the ice-basketball power-up in Chaos in the Windy City has no effect on polls of water. The feedback a videogame gives the player from common situations in videogames depends on the context of the videogame.

Principle 3: Input Amplification

The Input Amplification Principle is directly related to the Semiotic Interaction Principle. The Input Amplification Principle is the amount of feedback a player gets from the Semiotic Interaction Principle. When a player pushes a few buttons on a controller, the feedback given back could be points, coins, a power-up, explosion, or all of the above. When I play Ultimate Mortal Kombat 3 (UMK3) for the SNES, I get so much feedback from my inputs. UMK3 is a fighting game best known for its graphic feedback and creative death sequences. If a player is crouched down (by holding down the down arrow on the directional pad), then pushed the button for hard punch, this will make the character perform an uppercut. If this uppercut connects with the other character on the screen it will toss that character high in the air, spilling blood on the floor, taking a lot of life off that characters life-bar, and landing hard on the floor. Depending on the level, the character who receives the uppercut may go through the ceiling entering a new stage to continue the fight. Videogames are notorious for giving the player a lot of positive feedback from a single input.

Negative feedback is not treated the same way in videogames. If the player's character is hit, they may lose a power-up or lose some of the character's life-bar/life-cluster. The character might flash repeatedly, rendering the character momentarily invincible so the player can recover from the feedback that was given. One videogame that flips the paradigm upside-down is Sonic the Hedgehog. In Sonic the Hedgehog, the most prominent feedback the player gets from input in speed. The screen moves by in a rapid pace. Sonic can spin jump on enemies, spin run thru enemies, and get power-ups that make him invincible towards enemies. Every enemy Sonic defeats releases an animal that was trapped in the defeated robotic enemy. This feedback is small in comparison to what happens when Sonic gets hit.

When Sonic gets hit, he loses all the rings he grabbed while progressing thru the level. If Sonic had 5 rings, he loses 5 rings. If Sonic had 30 rings, he loses 30 rings. If Sonic had 99 rings, he loses 99 rings. This type of feedback reinforced a player that mistakes can be costly, so try not to get hit. A well-designed videogame tries to strike a balance of caution with high-rewarding positive feedback.

This principle is not at all exclusive to videogames. Science, mostly chemistry, tends to operate on this principle. In chemistry, “you mix a few chemicals and make a major discovery, cure cancer, or blow up the lab” (Gee, 2008). Although chemistry also has the none-feedback or none-reaction mixtures as well, it is when chemicals mix and do react that the principle is fully in play. This also extends into a more basic form of chemistry, cooking. It is as evident as having a salad with only vinegar, compared to having the same salad with balsamic oil and vinegar. The challenge when translating this principle into the secondary mathematics classroom, is balancing the caution, with high positive feedback.

Principle 4: Identity Adaptation

The Identity Adaptation Principle is the interaction between the player's “real-world identity” and the “digital-world identity” (Gee, 2008). When a player starts to play a videogame, they gain “the potential to join and collaborate with a new affinity group” (Gee, 2007). The player is not only living and interacting in the real-world with their personal identity, but they can now interact with a specific group of people to discuss hints and tips for specific games. The player could have went to the arcade and interacted with other players or gamers. While I would have never fought my older cousin in real-life, I did talk trash and fought my cousin in Street Fighter II Turbo for the SNES. A player does not need to be a fighter in real-life to playing a fighting game. In fact, a player does not need to even act out a fantasy to enjoy playing a videogame. While there is much research being done to look at the affects videogames, like Grand Theft Auto and Call of Duty, may have on a player's morality, the focus of this principle is about the commitment players make to play a videogame thru an adapted identity.

In conjunction with the Semiotic Interaction Principle, a player can build commitment to play a game as they build understanding of the language and “algorithm” within the videogame. I made to commitment to play and try to beat Earthworm Jim for the SNES because I understood that the main character was a worm in a power suit with a laser, who would use his head as a whip and grappling hook, launch cows into the air, and spin his head round like a helicopter to slow his decent from heights, because it was simply ridiculous. As a player, I wanted to see how far I could take Jim into this world and try to learn what else this earthworm could do. As James Gee (2008) believes “such a commitment requires that [I am] willing to see [myself] in terms of a new identity, that is, to see [myself] as the *kind of person* who can learn, use, and value the new semiotic domain.” A player commits to try an beat a videogame because they interpret the feedback from the input they put into a game, understand the “algorithms” of success, and wonder how the character or “new identity” can progress thru the “digital world' (Gee, 2007).

Would a player play a videogame if they did not have success playing a different version of that game? It was easier for me to be committed to try to beat Earthworm Jim 2 for the SNES when I had success with the character in the first game. However, I did have a harder time making the same commitment to beat Super Ghouls 'N Ghost when I was not able to beat the NES version. This is a problem of pre-constructed identity, and is easily translated into the classroom. If a student failed their 8^{th} grade math class, what type of confidence or commitment will they bring into a 9^{th} grade high school math class? Unraveling that question and trying to find answers is the focus of later papers. This is not a coop-out, because engaging in that topic now is outside the focus of this paper. I mentioned the connection to highlight my recognition of previously constructed identities and “new identities” in gaming and school.

Principle 5: Low-Risk

The Low-Risk Principle is represented by the life-bar, life-cluster, save-points, and continues a videogame has. Gee (2008) asserts that “videogames create […] a learning space in which the [player] can take risks where real-world consequences are lowered.” In our real-world, we only have one life, no life-bars or save-points. We do have indicators like our health and age, but we do not have do-overs, reset buttons, or mulligans. Save-points and life-bars establish that it is okay for a player to make some mistakes.

One beauty found in some SNES games is when a player does not make a mistake. If the player defeats their opponent without receiving damage playing Street Fighter or Mortal Kombat, they earn a “PERFECT!” or “Flawless Victory” respectively. When a player plays Super Ghouls 'N Ghost and gets consecutive power-ups without getting hit, the suit of armor gets stronger and power-ups the equipped weapon. In fact, the concept of power-up, not only create more game play variety, but it also makes the game easier. Why use a sword to defeat your enemies when you can use a gun, and why use a gun when you can use a tank? Power-ups make a player feel powerful and confident that they can continue trying to beat the game. However, some videogames make the player lose all their power-ups when they die, and some videogames allow the player to keep all obtained power-ups. A well-designed game balances the Low-Risk Principle with increased videogame difficulty.

Principle 6: Actuated Difficulty

The Actuated Difficulty Principle is the modifications a player can make to increase or decrease the videogames difficulty. 23 (46%) out of the 50 SNES games I own have the Actuated Difficulty option. Some videogames have a level from 0 to 10 to customize difficulty. Some videogames have an 'easy', 'medium'/ 'normal', and 'hard' settings to customize difficulty. Player will customize difficulty based on why they are playing the videogame in the first place. Players “differ in a variety of ways, including how much they are willing to challenge themselves, and they play videogames for a great variety of different purposes” (Gee, 2008). I extrapolate this principle with one of my favorite PS2 games Dynasty Warriors 4 (DW4). DW4 is an Action-RPG Beat-em-up game. The player picks a character, builds their weapon, earns power-ups, and increases ability stats by defeating enemies and fulfilling objectives. The game is set in China and is based on the Romance of the Three Kingdom novels. Sometime I play the game on “easy” so I can just beat-up hundreds on enemies and cause carnage. Sometimes I play the game on “normal” to play the story mode and build a character's stats. Sometimes I play the game on “hard” so I call challenge myself and attempt to unlock new power-ups and weapons. The reasons a player will modify a videogame are just as various as the players who are playing the game.

I labeled this principle Actuated Difficulty because the player's decision about difficulty changes the feedback the videogame gives. A higher difficulty setting could mean enemies take more hits to defeat, an increase in objectives and goals, or lower probability of power-up appearances. It also could mean more levels are available, more types of power-ups are available, and different videogame endings are possible. I remember playing Demolition Man for my SNES and being so upset that playing the game on “easy” meant I could not truly finish the game because those levels were only available for when difficulty settings were higher. I also remember being frustrated when I played Teenage Mutant Ninja Turtles IV: Turtles in Time, and I would beat the game and the screen would read “Try on a Higher Difficulty.” My anger or frustration stemmed from feeling unrewarded for my hard work, but it did prompt me to try the harder levels and try to beat the videogame. The Actuate Difficulty principle is an option to include in a videogame. They are many popular and reputable videogames that do not employ this principle: Super Mario World, Mega Man X, Super Metriod, Legend of Zelda: A Link to the Past, the Pokémon videogame series, the Final Fantasy videogame series, and the Donkey Kong videogame series. The challenge of designing a videogame that utilizes this principle is to make sure the principle motivates a player to challenge themselves to experience the full-storyline of a videogame. Although I am a gamer, it still was a challenge of egotism, to play every level and beat a game on “easy”, just to be prompted with trying a harder difficulty.

Principle 7: Storyline

The Storyline Principle is one of the key drivers for emotional investment in playing a videogame. Much like narrative novels and movies, the storyline can foster a reader, watcher, or player to connect and understand different characters and the relationships between those characters. While novels and movies are streamlined storylines, videogames, by nature, require a player to be interactive in driving the storyline forward. When the player is playing a videogame, they are the “receiver of the narrative” and want “to interact with and influence” the narrative “on the fly” (Prensky, 2001). Many SNES games like Joe & Mac and Aero the Acro-Bat 2 begin with the storyline presented with text and moving images, which were followed-up with the player being able to play the game and progress level by level to reach the end goal. Due to the popularity of videogames during the 4^{th} Gen era, many SNES games were licensed from movies like Batman Returns and Super Star Wars. In those games, the storyline was most likely known by the player, yet the player was still motivate to get to the point when they had to escape the “Cave of Wonders” when playing Disney's Aladdin for the SNES.

There is one key difference between novels and movies, and videogames, and that is how players deal with or encounter death. In a novel or movie, when a main character dies, it can be heavy and even cause the reader or watcher to cry (think Mufasa's death in Disney's Lion King, ***SPOILER ALERT Albus Dumbledore's death in Harry Potter and the Half-Blood Prince). While in videogames, mostly resulting from the Low-Risk Principle, when the main protagonist dies the player either re-spawns from a previous location, save-point, begin the level again or is asked if they want to continue. Deaths in videogames become a greater source of frustration as the player retries the level after a failed attempt.

Due to technological advancements in videogaming, there is a near convergence between novels, movies, and videogames in making death more emotional to the player. Videogames not only have cinema-like cutscenes, full-orchestrated music, and amazing graphics, but they are also longer. The vast majority of SNES games can be played and beat within an hour or so. However, the genre of videogames known as Role-Playing Games (RPGs) started the trend of extending the length of game play. I remember spending close to 20 hours to beat Final Fantasy III for the SNES. When Final Fantasy games were developed for the Next-Gen videogame systems, a player could easily put-in over 40 hours of gameplay to beat the game. That is a lot of time for character and storyline development, and emotional investment. While a movie may average 2.5 hours, the amount of hours put into a videogame rivals the amount of time it can take to read a novel from beginning to end.

Principle 8: Materia Conservation

The Materia Conservation Principle is how a player decides to use materials, power-ups, and objects in a videogame when the materials, power-ups, and objects are limited. I used the word Materia because it comes from the Final Fantasy videogame series, not because it is Latin. Some videogames give a player a set amount of times they can perform a magic power or use an object. If a player comes across a high-powered weapon, then that player might decide to save that weapon for a boss or really tough enemy. This principle is most prevalent in Action and RPG games. While Mario gets a fire flower in Super Mario World and shoots unlimited fireballs, in Mega Man X for the SNES, there is a power gauge for the flame thrower power-up. While in Super Strike Eagle for the SNES, there is limit ammo and missiles for the player's F-15 Eagle, they would get unlimited ammo for their spaceship in Darius Twins for the SNES.

The player’s decision, to conserve power-ups or items, depends on the context of the game. Playing a videogame like Street Fighter would be completely different is punches, jumps, and kicks were limited. Imagine playing a fighting videogame in which the character could get tired and punches and kicks dealt less damage. Imagine if special moves took away the player's energy, much like super moves do when performed in videogames. Some racing videogames have a fuel gauge, and some racing videogames do not. Well-designed videogames have a “flow” to them, a well-paced action to them. The pace and Semiotic Interaction of playing Super Mario Kart would be ruined if a player had to stop for gas. The ability for a new player to pick up a fighting videogame and just button-smash, would yield little to no success if players had to worry about tiring-out a character; especially when that player's primary focus is on figuring out the buttons and necessary input to understand the videogames “algorithm.” The Materia Conservation Principle adds complexity to a videogame and most videogames present a “break” (or the player can push a button to enter a menu screen to select the materia they will use for the situation) in the action so a player can respond critically to the complexity of the situation in the digital environment.

Principle 9: Forked Pathways

The Forked Pathways Principle is the options a videogame has in its design that allows the player to choose how they will go about achieving a goal. Some of the levels in Super Mario Kart have short-cuts and it becomes the player's decision to take those short-cuts or not. Some short-cuts require a specific power-up, and have a high-cost and high-reward in being successful in taking the short-cut. Not every Forked Pathway is a short-cut; some are considered “out-the-way” bonus rooms and items. In Super Metriod a player would need to take their time going thru the game to locate extra missiles, power-ups, and save-point rooms. A player must find all items, locate all bonuses, and defeat all bosses, even side/ bonus bosses[4] in order to complete a videogame 100%.

In Super Mario World, a player must take chances and replay previous levels to find secret areas or unlock alternative routes. A player can progress linearly to try and beat Super Mario World, but the challenge is unlocking other paths and switches to change how the game will progress. The Forked Pathways Principle does not alter the goal of the game, but it provides multiple approaches to get to that goal. Some videogames are linear in how a player can progress forward, like SNES' Prince of Persia, Super Ghouls 'N Ghosts, and Battletoads & Double Dragon. The fine-line in Forked Pathways is how characterized how off-the-beaten-path a bonus Boss, item, or unlock-able achievement is from the linear path.

Principle 10: Scaffolded Training

The Scaffolded Training Principle is a very unique feature in videogames. I define the Scaffolded Training Principle as the way a videogame is design to teach or allow a player to learn how to play and interact within the videogames environment. What makes this principle different from the Active, Critical Learning Principle, is the “space” a player is given to learn the game. In Star Fox for the SNES, the player can choose the option “Training.” This option gives the player a chance to learn

4 A side or bonus boss is a boss found in a videogame that is present to serve as a challenge to the player and/or give the player a reward that makes the game easier. Most side or bonus bosses do not further the main storyline in a videogame.

how to fly, shoot, and maneuver the spaceship thru obstacles “in a Sub Domain of the Full Domain” (Gee, 2008). In Prince of Persia for the SNES, the player can also choose the option “Training.” The player plays thru multiple shorten levels to work on specific skills when playing the full game. The player practices hanging, short jumping, and running skills in the first level. Then the player practices consecutive jumping skills in the second level. Then the player practices long-jumping and running skills in the third and fourth levels. Finally, the Training ends with the player practicing sword fighting in the fifth level. Training does not need to be as clearly identified as it was in Prince of Persia or Star Fox. Some racing games have the option of practicing using time-trial runs, and some training is simply shown to the player throw computer led tutorials like in Kirby's Dream Course. This principle is found in 12 (24%) of my SNES games, however 4 of those games are racing games. This may mean videogame designers and developers choose to rely on the Active, Critical Learning Principle, rather than developing a training mode or level.

Well-Designed Examples

These ten principles do not have to be present in one videogame to make it a well-designed game, but it is when those principles are used effectively in one game that we come across a special videogame. I want to talk about my favorite SNES videogame thru the lens of the principles identified above.

Mega Man X

Mega Man X is the first Mega Man videogame designed for the SNES. It added three elements to the original gameplay from the NES Mega Man games: wall-jumping, dashing, and smooth screen transitions. Mega Man X has 9 of the 10 mentioned principles, the Actuated Difficulty Principle is the only absent principle. The music is Mega Man X is crafted to the mood in each level and is very fitting.

When the player defeats an enemy, they hear a satisfying explosion and are left with either, an extra-life, energy capsules, or power capsules. Mega Man X has two very clever elements in its design that highlight how creative a game came be in implementing the Scaffolded Training and Forked-Pathways principles.

When the player turns-on Mega Man X, they are presented with three options: Game Start, Password, and Options (which only allows the player to customize the controller layout). Once the player chooses Game Start, they start a level that begins on a highway where they have to move right to progress the screen. The first few enemies the player meets practices the players shooting, jumping, and dodging skills. The player learns that there are some enemies they can jump over, some who have specific spots to shoot at, some that release other enemies, and some enemies that leave behind pieces when partially destroyed. During this initial level, the player meets a large enemy that causes the screen to lock in place, thus indicating the need to defeat this enemy before moving forward. In videogame terms, we call this type of enemy a mid-boss or half-way boss, because this type of enemy usually shows up when a player is half-way thru a level. By the end of the level, the player has learned they can wall jump, charge their weapon, and get more background on the storyline. The level concludes with Mega Man encountering a robot in a larger robot suit and feeling helpless as the game is designed for Mega Man to lose and be saved by his friend Zero. Of course, if this is the player's first experience playing the game, then they do not know this, let alone, there are no enemy life-bars to indicate if the player is inflicting damage.

The game then shows the player a password and continues under the storyline arc that Mega Man and Zero are trying to defeat Sigma (the game's main objective) and that Mega Man may become stronger on the way to achieving that goal. The first level acts as a training level to learn about the current capabilities of Mega Man, the environment, and the storyline of the game. It is brilliant! From there, the player can choose any of the following eight levels, indicated by the boss of that level, the specifications of that boss, and the location of that level on a map.

This highlights the Multiple Routes Principle in its full creativity. The player has free choice of which level to choose, and as the player plays a level, depending on the order they beat levels, they might find extra items and power-up along the way. There are a total of 8 heart sub-tanks (which increase Mega Man's life-bar), 4 energy tanks (which can be used to refill Mega Man's life-bar), and 4 enhancement capsules (which enhance Mega Man's speed, defense, blaster, and strength to break boulders). The player must replay some levels to obtain all the items. Some items are available once the player has beaten a specific boss, which affects another level. When the player beats the Chill Penguin level, it results in the Flame Mammoths level no longer having lava and flames, because it is cooled off. This makes the heart sub-tank that was floating over lava accessible as the lava is replaced with ice. The is not told which level can affect each other, nor is the player told how many of each item there is. This makes the option practically limitless as a player can progress through the game in any order they see fit. This may prompt a player to explore all the stages (and re-explore levels when new abilities are acquired) with Mega Man and take risks.

Mega Man X is a perfect example of the principles being used in a creative and useful manner. When a player is able to obtain all the items and powers from the bosses they defeated, they are then truly powerful enough to try and beat Sigma. No matter if the player obtained all the power-ups, the player is shown a cut-scene, after defeating the 8 levels, of Zero and Mega Man getting ready to fight Sigma. A new level is reveal showing only Sigma's face. The player selects the level and during that level Zero sacrifices himself so the player can beat the robot that beat the player in the opening level.

Then the player is tasked with beating another Boss and selecting the level twice more to beat all the bosses again as mid-boss to get to the boss of that level. Now that Mega Man has all the powers at his disposal to fight the “mini”-bosses, they player may discover that some of these bosses have weaknesses from the powers you gained! This increases the replay-ability of Mega Man X as the player can try to beat the game again with the new experience built from playing the first time.

The Challenges

Follow-Up Papers

So, how do we use the Ten Principles of Videogames in the secondary mathematics classroom? This is one of the next steps for my research. In presenting the Ten Principles, I raised a few questions, especially around a player's and student's identity. In my next paper I will delve into how identity is influenced in cooperative and competitive environments in videogames. I will expand my research to include Massively-Multiplayer Online Role-Playing Games (MMORPG) like World of Warcraft (WOW) and Call of Duty (COD). I will also conduct some interviews and observe how players play and interact with other players when playing cooperative and competitive videogames. The goal is to use that research to help structure the ideas of how to translate the Principles into the secondary math classroom.

Gamification

There has been one word that keeps coming-up in my research and when I share my research with people, Gamification. Gamification is the concept of using the theory and mechanics of games to make the proposed recipient more engaged in problem solving. However, Gamification is not a concept exclusively research for use in the classroom. It is a broader concept for simply making non-game settings and situations, more like a game to hopefully foster engagement. My research is more focused on the implications of videogame theory and design in the secondary mathematics classroom. Some educations have used Gamification in their classroom, turning the classroom environment into a game and allowing students to create avatars. While I am not fully opposed to Gamification practices in the classroom, I am suggesting of trying to use the principles are guides and underlying foundations for teaching practices. I am not suggesting that we need to make the classroom a videogame to get the benefits of engagement videogames have. Gamification will continue to be a concept I encounter in my research and perhaps a concept I will modify as I move forward. I simply wanted to clarify the difference in the goals of my research when compared to the concept of Gamification.

Conclusion

Reflection

Clearly I have my work cut-out for me. However with the Ten Principles of Videogames (Active & Critical Learning, Semiotic Interaction, Input Amplification, Identity Adaptation, Low-Risk, Actuated Difficulty, Storyline, Materia Conservation, Forked-Pathways, and Scaffolded Training), I can hone my creative thinking into each principle to come-up with some ideas (or share some ideas already being used in secondary math classrooms). The true challenge will be in evaluating whether the translations, that will be made, are more than just “good teaching” practices. While I am at it, would I truly need to evaluate that? Perhaps I could make a case reinforcing practices thru the lens of the principles in videogames. As this research moves forward, I look forward to having that discussion because those are the discussions that further, not only my practice of teaching, but other’s as well.

APPENDEX

The following is a list of all the videogames mentioned in the paper and respective youtube links to watch game footage of that game. I do not own the videos or share the same perspective as the original creators of the youtube videos.

•Aladdin (SNES)- http://www.youtube.com/watch?v=37T47gbOB40
•Batman Returns (SNES)- http://www.youtube.com/watch?v=7BaHhN1J7x4
•Call of Duty (Xbox 360 & PS3)- http://www.youtube.com/watch?v=HXCZBlMKZr0
•Chip 'N Dale: Rescue Rangers (NES)- http://www.youtube.com/watch?v=oGd82QUon8M
•Darius Twins (SNES)- http://www.youtube.com/watch?v=Otws5qZ0S1A
•Donkey Kong Country (SNES)- http://www.youtube.com/watch?v=hakuztODkAw
•Dynasty Warriors 4 (PS2)- http://www.youtube.com/watch?v=tX09q0yM3cc
•Earthworm Jim (SNES)- http://www.youtube.com/watch?v=EolW7ZxAOJ8
•Final Fantasy 3 (SNES)- http://www.youtube.com/watch?v=s_EDnDJvlw8
•Ghouls 'N Ghost (NES)- http://www.youtube.com/watch?v=aLTQRJXzwP0
•Goof Troop (SNES)- http://www.youtube.com/watch?v=HXDHROWePZg
•Grand Theft Auto (PS)- http://www.youtube.com/watch?v=LhbzdeHo_Cg
•Joe & Mac (SNES)- http://www.youtube.com/watch?v=VnnhNPQZ-iA
•Kirby's Dream Course (SNES)- http://www.youtube.com/watch?v=KdTHOUY_UvE
•Legend of Zelda: A Link to the Past (SNES)- http://www.youtube.com/watch?v=qh-3jz7I_Uc
•Mega Man X (SNES)- http://www.youtube.com/watch?v=wd2NqblSmIY
•Michael Jordan: Chaos in the Windy City (SNES)- http://www.youtube.com/watch?v=9JnUbTEPW7Y
•Mickey Mouse's Magical Quest (SNES)- http://www.youtube.com/watch?v=d7g17h-KOxg
•Off Road (NES)- http://www.youtube.com/watch?v=nMEg-xMxCXk
•Pokémon (GB)- http://www.youtube.com/watch?v=tuEXwn3vGIU
•Pong (Atari)- http://www.youtube.com/watch?v=t-PAIlWh2R4
•Prince of Persia (SNES)- http://www.youtube.com/watch?v=FK6SxVJkeDk
•Sonic the Hedgehog (GENESIS)- http://www.youtube.com/watch?v=YH3o5LNJuFA
•Star Fox (SNES)- http://www.youtube.com/watch?v=k8dxLr_xVv4
•Street Fighter II Turbo (SNES)- http://www.youtube.com/watch?v=XLVoMW-OVyg
•Super Ghouls 'N Ghost (SNES)- http://www.youtube.com/watch?v=HqTmSNn1PBY
•Super Mario World (SNES)- http://www.youtube.com/watch?v=4YxRb4bKbMI
•Super Mario Kart (SNES)- http://www.youtube.com/watch?v=AlAmXXNz5ac
•Super Metriod (SNES)- http://www.youtube.com/watch?v=RXVA_RDzxss
•Super Star Wars (SNES)- http://www.youtube.com/watch?v=k8M6lTwNfRw
•Super Strike Eagle (SNES)- http://www.youtube.com/watch?v=Vl15fVJlhbg
•Teenage Mutant Ninja Turtles IV: Turtles in Time (SNES)- http://www.youtube.com/watch?v=nGkfAfDWVh0
•World of Warcraft (PC)- http://www.youtube.com/watch?v=Z1DGW6KIUsc
•Ultimate Mortal Kombat 3 (SNES)- http://www.youtube.com/watch?v=8QsvthyLuxE

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