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Gaming the Education System: Interactive Game-Based Learning

Mackenzie Haydon

GAMING THE EDUCATION SYSTEM: INTERACTIVE GAME-BASED LEARNING

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Mackenzie Haydon

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Thesis written by

Mackenzie Haydon

Approved by

Thesis Advisor

Thesis Reader

Accepted by

Director, University Honors Program

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Literature Review

Video Games and Learning

Do games help students in the classroom?

This article helps to outline the basis of games and explores the use of games in the classroom. It looks at current games and their revenues as well as the demographics of those that play the games. It also examines state test scores of Okeechobee, Florida and how those test scores changed with the use of games in the classroom. In using this article, I am hoping to get a larger overview of where gaming is present today and where it can grow, like education, because recreational gaming is so widespread with the higher use and growth of technology. As of right now most of the information will go more into the introduction and background of what is gaming and where is it found today.

Ault, Alicia. "Video Games and Learning." *CQ Press*. SAGE, 12 Feb. 2016. Web. 1 Apr. 2016.

Game-Based Learning: What it is, Why it Works, and Where it's Going

“The ideal of interactive, highly-engaging training and education is ancient. A Chinese proverb says: "Tell me, and I'll forget. Show me, and I may remember. Involve me, and I'll understand." However, the gap continues to grow between antiquated, passive training methods and a workforce that lives an ever more interactive, multimedia, user-

controlled lifestyle. With game-based learning tools to bridge that gap comes the promise of vastly more productive and engaged students and workers—ones who embrace learning rather than view it as a disruptive burden. This article lays a framework for Interactive Game-Based Learning in the modern era. It introduces topics like interactive, engaging games as well as where it is currently in place. It also touches on the differences between traditional teaching and the IGBL environment and why it was not used in the past but is very important in the future of learning.

Trybus, Jessica. "Game-Based Learning: What It Is, Why It Works, and Where It's Going." *New*

Media. New Media Institute, n.d. Web. 21 Oct. 2016.

Dynamic and Interactive Mathematics Learning Environments: Opportunities and Challenges for Future Research

A general discussion about the growth of technology within classrooms and how it affects the classroom and interactions within them. It also looks at the differences in the games, geared towards mathematics, that are available online currently outside of the education system and their appeal as well as who designed them. Calculation nation vs. Club Penguin and what they teach. A look at more mathematics focused games and research and how that ties into where I am at currently as well as going more focused into a specific part of the education rather than the system as a whole. Also shows the difference in usership between appealing games made by game designers rather than those created solely by teachers and professors.

Olive, J. (2013, July). ERIC - Dynamic and Interactive Mathematics Learning Environments:

Opportunities and Challenges for Future Research, Online Submission, 2013-Jul. Retrieved April 01, 2016, from http://eric.ed.gov/?id=ED544153

Calculation Nation and Club Penguin and The Witness

These are two current games out there designed for younger children in order to teach them mathematics, in the case of Calculation Nation, and more broad skills such as: motor skills, creativity, teamwork, money management, global awareness, socialization, and responsibility. In looking at these I can see some current examples along with others, such as the Wuzzits by Keith Devlin, as to how mathematics and videogames are currently being put together. Through these I can also see the imbalance between games made by Mathematics professors, Calculation Nation, and those created by game designers in order to try to find a point of collaboration and balance between fun and learning in order to better engage students in the learning within the classroom and encourage them to take it beyond the classroom as well. In examining the witness based upon other research I felt that it was a good model for other possible mathematics games. While it is not necessarily oriented towards mathematical concepts the puzzle solving skills are useful in problem solving as well as providing a good understanding of exploratory game worlds. Players can move from puzzle to puzzle to explore the world and see how each puzzle builds into a different version. Puzzles become increasingly harder and concepts are combined. In order to advance through the game that rules and basic concepts must be understood and applied by the player.

Calculation Nation® - Challenge others. Challenge yourself.®. (n.d.). Retrieved April 01, 2016,

from http://calculationnation.nctm.org/

Parents. (n.d.). Retrieved April 01, 2016, from

http://www.clubpenguin.com/parents?country=US

The Witness. PlayStation 4 version. Johnathan Blow. January 26, 2016. Video Game.

Mathematics Education for a New Era: Video Games as a Medium for learning

This book will become the guide that I base most of my thesis on. It looks at current games out there for mathematics and what they look like in order to see where collaborations would happen between teachers and game developers to incorporate lesson plans into games and better engage student learning. Devlin also explains why video games are the ideal medium for middle school math which will help me to narrow my thesis to a specific grade level. This book will probably aid more of the back half of my research as it focuses specifically what is involved in designing and producing educational mathematics videogames that "foster innovative mathematical thinking skills necessary for success in a global economy." This work is primarily aimed at teachers and educational researchers so I think that this will lend itself well to my thesis and the research I still have as a guide and overall backbone to the latter half of my paper.

Devlin, Keith J. *Mathematics Education for a New Era: Video Games as a Medium for Learning*.

Natick, MA: K Peters, 2011. Print.

Video Games and Learning: Teaching and Participatory Culture in the Digital Age

Looking more broadly for the first portion of the paper I would use this book as a big stepping stone in describing what exactly video game education looks like and how educators and curriculum designers can make the most of the participatory nature of digital media and games. Squire presents a comprehensive model of games and learning that integrates analysis of games, games cultures, and educational game design. Having done over ten years of research on the subject I believe that much of his knowledge is useful to help guide my thesis and the reader into what exactly games and education look like together. This book as well as other works of his will help me give a wide overview of what gaming education looks like currently and where it can move to in the future.

Squire, Kurt, and Henry Jenkins. *Video Games and Learning: Teaching and Participatory Culture*

in the Digital Age. New York: Teachers College, 2011. Print.

National Council of Teachers of Mathematics – Principles and Standards for School Mathematics

These standards along with the Website will help to examine where we currently are within Mathematics education and what the standards are for each student, kindergarten through high school. It provides a set of rigorous standards designed with college and career readiness in the 21st century. It outlines the essential components necessary and emphasizes the need for well prepared and well supported school staff in order to increase students learning and the overall program's effectiveness. In looking at

and analyzing what these standards are within a middle school classroom I can better see where current games might be lacking, and where future games can go in order to better meet these standards while being fun and engaging in order to better engage and teach the students.

"Index - National Council of Teachers of Mathematics." *Index - National Council of Teachers of*

Mathematics. N.p., n.d. Web. 22 Apr. 2016.

Interactive Game-Based Learning and its Importance

"Deconstruct the fun in any good game, and it becomes clear that what makes it enjoyable is the built-in learning process" (Trybus). Take a game, such as the Witness, and look at the bare bones of what the game is: The player learns the rules of each puzzle to solve the next and figures out how to solve each area. To progress in the game the player actively engages in a learning process specific to the game and the fun comes from the pleasurable experience of solving a new system and using this solution. A game engages a player in a way that traditional education lacks and offers a new medium for learning that actively involves the learner in their own learning process.

In a classroom learning can become stagnant or dull and when this happens it is often because the learner is unmotivated and unengaged with the material. Allowing for more time in a classroom is not the solution because it allows for more disconnect from the material. What is needed to reduce this "dull" learning are "effective, interactive experiences that motivate and actively engage us in the learning process" (Trybus). One solution to this is the implementation of Game-Based Learning. Educational games are not a replacement for teachers and schools but another tool that they can use to keep students involved in the learning process.

A good game will draw the learner into the virtual environment in a way that feels familiar or fun while working the learner towards a goal. Within the game the learner is able to experience the consequences and rewards of their actions and choices nearly immediately and can make mistakes in a risk-reduced setting. The learner actively learns

and practices the right way to implement the rules of the game. This keeps the learner engaged in practicing the rules and behaviors that can be transferred to further learning or real world situations.

In contrast, traditional learning only tests a student's memory and practice of a narrow subject with limited involvement and grades them based upon their retention. Hands-on learning provides us with a different way of learning and has been proven effective but often times is seen as too time consuming or that it cannot cover all of the material. Games, and simulations, provide an interactive environment that can feel hands on and engaging while allowing for more traditional learning to happen as well. A good, interactive game inspires students to continue the learning process on their own while allowing them to progress and explore within the simulated environment(s).

In the modern era games, and media in general, have become increasingly involved in the everyday lives of a wide range of people but especially those of a younger age. "More than 150 million Americans — nearly half the population — play video games on a personal computer (PC), TV, game console or portable device, with 42 percent playing at least three hours a week, ESA said. About 10 percent of Americans identify themselves as "gamers," according to Pew. And 97 percent of children play computer and video games" (Ault).

With so much of a child's time and attention being pulled away by games and media entertainment the ability to tap into this form of engagement and utilize it for learning is invaluable. Interactive Game-Based Learning at its core has a defined set of learning outcomes but balances these outcomes and subject matter with gameplay in

order to promote knowledge and skill based retention and promote the application of subject matter. In the past these methods were only available to those that could afford to pay for the technology but with so many technological advances being made more available to the public at a lower cost the uses of game-based learning can grow and expand.

It is important for us to look at new ways of teaching and learning, especially in the United States, because our education has grown stagnant. Many students find it hard to connect with the learning done in the classroom and the engagement and interaction that games provide can offer a new way for students to connect to the basic ideas and concepts and promote learning and interest outside of the classroom.

According to a study done by Pew Research Center, the United States ranked 35th in Mathematics in 2012 and 36th in 2015 internationally. In a "Pew Research Center report, only 29% of Americans rated their country's K-12 education in science, technology, engineering and mathematics (known as STEM) as above average or the best in the world. Scientists were even more critical: A companion survey of members of the American Association for the Advancement of Science found that just 16% called U.S. K-12 STEM education the best or above average; 46%, in contrast, said K-12 STEM in the U.S. was below average" (Desilver). Our education system has improved, as our scores are higher than they were twenty years ago but we are still ranked in the middle of the pack and are behind many other advanced industrial nations.

In looking at the top contenders on the Pew reports, Hong Kong is one that sticks out. Though not a very large movement, Game-Based Learning is present and growing within the education system of Hong Kong. The Hong Kong Digital Game-Based Learning Association was established in 2008 and is partnered with different universities and companies across Hong Kong. ” Since 1998, the Hong Kong government has been determined to promote information technology in education. Three IT in education strategies have been launched and a huge amount of resources has been allocated to promote, through IT, a “paradigm shift” in school education from a textbook-based and teacher-centered mode to a more interactive and learner-centered mode” (HKDGBLA).

There is a similar movement beginning in the United States, and more specifically New York, called the Institute of Play. “We create learning experiences rooted in the principles of game design—experiences that simulate real world problems, and require dynamic, well-rounded solutions. We support teachers and other learning leaders in making learning irresistible—creating for students a powerful need to know, and a hunger to learn more. We believe in making learning relevant—to the technologies that shape our kids’ lives, the passions that fuel their ambitions, and the demands of life in the 21st century” (Institute of Play). Through games they try to create a desire to learn that will extend beyond a classroom setting and become something that students continue the rest of their lives. The Institute of Play is not solely focus on video games as learning tools and explores all types of game play. While this is a good approach to have, it is not something that will be discussed in this paper. The Institute’s approach to learning through its Quest schools is unique and innovative but relies on games as the primary

mode of learning rather than a tool for teachers that can be used in a classroom by teachers that already have certain methods in place. In looking at the top contenders on the Pew reports, Hong Kong is one that sticks out. Though not a very large movement, Game-Based Learning is present and growing within the education system of Hong Kong. The Hong Kong Digital Game-Based Learning Association was established in 2008 and is partnered with different universities and companies across Hong Kong. ” Since 1998, Hong Kong Government has been determined to promote information technology in education. Three IT in education strategies have been launched and a huge amount of resources has been allocated to promote, through IT, a “paradigm shift” in school education from a textbook-based and teacher-centered mode to a more interactive and learner-centered mode” (HKDGBLA).

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something that will be discussed in this paper. The Institute's approach to learning through its Quest schools is unique and innovative but relies on games as the primary mode of learning rather than a tool for teachers that can be used in a classroom by teachers that already have certain methods in place.

We need to create a new tool for teachers to use both inside and outside the classroom. Students need to be engaged in the learning process in order to promote curiosity and creativity in a subject. Students need to be encouraged to discover through learning rather than traditional learning with rote memorization and a steep price of failure resulting in fear. "The ideal of interactive, highly-engaging training and education is ancient. A Chinese proverb says: 'Tell me, and I'll forget. Show me, and I may remember. Involve me, and I'll understand.' However, the gap continues to grow between antiquated, passive training methods and a workforce that lives an ever more interactive, multimedia, user-controlled lifestyle. With game-based learning tools to bridge that gap comes the promise of vastly more productive and engaged students and workers—ones who embrace learning rather than view it as a disruptive burden" (Trybus).

What we can Learn From Games

According to Keith Devlin, a prominent mathematician and professor at Stanford University, there are ten Key Features of gaming:

1. Failure doesn't hurt
2. Risk is part of the game
3. Feedback needs to be immediate
4. Used to being the "star"
5. Trial and error is almost always the best plan
6. There's always an answer
7. I can figure it out
8. Competition is fun and familiar
9. Bosses and rules are less important
10. Used to group action and conflict.

Many of these features go against the traditional classroom learning and testing environment.

In any classroom, especially in early mathematics, failures can compound on one another and result in the student giving up on a subject altogether because they will never "catch up." Failure is seen as negative and hurts the student because the teacher and class move on when most students understand a topic while others get left behind. In a gaming environment there is less risk of failure, while risk is still prevalent and provides challenge. The failure that is experienced in a game is less harmful and can be learned from because it doesn't result in automatic failure and a lack of understanding. Depending on the game you can retry a level until the concept is understood and mastered. This idea of mastery and understanding is important. The player doesn't just master one piece of a game but as they progress through the game they begin to learn and understand the underlying rules and requirements of the game. Through trial and error,

the player learns the underlying rules and mechanics of the game world and applies these to different tasks and challenges that they are presented. In this way students can better learn and understand the rules and mechanics of mathematics and are able to apply the skills to different types of problems.

Risk is not as big as it in a classic classroom but is still present in a gaming environment. It is this risk and reward system that gives the player a sense of achievement. Without risk and reward a game becomes less engaging and therefore won't be as successful. It is this system of risk and reward that can be brought into the classroom to better engage participatory learning. It is not natural to think mathematically, just as it doesn't come natural to ride a bike, it must be learned and so risks must be taken. Public failure in a typical classroom is one place where students become less likely to engage in the learning because they see a greater risk of failure and become averse to trying anything new.

Feedback is immediate in a game because the player can understand, almost immediately after an action, if the choice that was made was the correct one or not. The same can be seen in a classroom setting but it is harder to implement. Homework and exams are ways that educators use to assess a student's understanding of a particular concept but feedback is displayed days after a student turns in their work. Teachers know that immediate feedback is good for students but it is hard to do so with so many students of varying skill and knowledge levels. Having this immediate feedback is becoming more common and is better for students to learn and adjust to minimize the overwhelming failure. There are some instances of this immediate feedback in the classroom: such as

voting or the “clicker” questions. This is helpful in some respects but is often underutilized and can only be used on those questions that are given in a multiple choice format. These types of questions often lead to a certain amount of guessing from the students which leads to either ineffective learning or a lack of learning of a given concept.

In a game environment, whether that is a solo game or one played with others, the player is used to being a “star” in the sense that they have a noticeable impact on how the game or level progresses. The same is not so for a classroom setting. It is typical to see one or two "star” students that receive more or most of the teacher’s attention while those that might need it more are often overlooked. Being able to bring this “star” persona to every student or group of students within a game situation helps students to learn because they receive more personal feedback from the game narrative or teacher. The more they succeed the more they can do because they gain a personal satisfaction from the achievement instead of only seeing their failures.

Trial and error is the one of the best learning tools and is often underutilized in a traditional classroom setting. In a game, a player is given basic commands like jump, run, and shoot and sent on to figure out the rest for themselves. There are guides along the way but most of the learning is done by the player outside of teachers. They are in a constant state of trial and error until they reach their goal. Failure isn’t detrimental and often leads a player to a new discovery and feedback is immediate to let the player know that their actions can be changed or improved. Trial and error is implemented to a point with homework assignments but there is weight and a risk of failure put on such

assignments. This risk of failure and delay of feedback puts so much pressure to achieve that many times students will just look up the answers to the questions instead of trying, and maybe even failing, to find their own way to the answers. There is also the point where current "traditional mathematics instruction rewards students who learn the rules and practice applying them" (Devlin, 77). This means that students are only rewarded for correctly learning and applying the rules and this reduces or eliminates the ability of trial and error.

In a game, there is always an answer and it's one that the student/player can find. This is important in any game and especially so in a mathematics classroom. If a student feels that there is not an answer or that the answer is one that they cannot figure out they become increasingly reliant on outside sources that inhibit their learning abilities. They turn to the textbook, teacher, or even the internet to find the answer rather than learning and practicing the rules of mathematics. In a game setting this is the fundamental idea. The player is required to learn the rules of the game if they want to get anywhere within a level and it is this that pushes players to learn. This challenge, can you solve the puzzle or beat the level, is why games are played. Players look to challenge themselves and their knowledge/learning abilities within the game against the game makers or other players and try to be the best. To beat a game is the ultimate satisfaction for a player and only through learning and practicing the rules can this be done. To find and solve all the challenges within a game no matter how large or small pushes a player to learn more and apply this learning in each challenge.

These challenges, or competitions, are fun and become familiar as a player becomes more invested in a game. Competition between friends or even strangers in a game motivates the player because this competition is done in a non-threatening way. There is no humiliation in failure or fear of being beaten. Classes where a "teacher can create a non-threatening, competitive environment usually produce excellent results" and in doing so can motivate students to learn and apply the rules to a challenge. This is not the case in most mathematics classrooms however and many students fear being "beaten" by a peer in the "competition." There is also the other side where some students fear "winning" because they do not want to stand out or become ostracized by their peers. The use of a videogame would provide a safe place for both kinds of students to be able to learn and practice mathematics.

In a game rules are made to be broken and bosses aren't as important to overall learning and experience. Players all over the world find fun and challenge in finding a new glitch or solving the smallest riddle. In large MMO, massively multiplayer online, games players try to find all the little easter eggs that are put into the game and many players try to find out how they can bend or even break the rules of the game. A player can learn more from battling smaller enemies in hordes rather than taking on a large boss and many times they even ignore these bosses altogether. Games also tend to lessen the importance put on experts that have been put into the game. These experts are good sources of information that a player can access when they want to but these experts are not necessary to a players learning and understanding of the game and their overall experience. The same is not true of a mathematics classroom because most of the

emphasis is put on achievement on a test or final exam and the teacher, no matter how nice or unassuming, is this all knowing, powerful authority figure. In using games as a learning medium the emphasis is put back on the learning and practice done by the student and the teacher becomes a resource that students can chose to use but is not the omniscient power figure that they are in a classroom setting. Students become less intimidated by this figure within a game and the teacher becomes more approachable to all students when and if they need help to learn.

A game, especially a multiplayer game, uses group actions and conflict to solve a challenge and explore the game. In a multiplayer game a group allows players the ability to come up with different ideas and ways to go about solving a challenge. Conflict is also a big motivator within a game setting because it presents the player with new incentive to tackle a difficult challenge within the game. Group work is used in a classroom setting with varying degrees of success based on the group's abilities and motivations. Sometimes a group project ends well, where all members of the group contribute and everyone learns from each other, but other times it ends up being one or two people that do the assignment. Conflict in a traditional classroom is not used for obvious reasons, but it is a powerful human motivator and can be utilized by teachers in a game environment. Some teachers try it when they create review games for class but not to the extent that conflict can be used in a true digital game environment.

Implementing Game-Based Learning is a challenge that will help students become more involved in their own learning process. Participatory learning is implemented in these games because it is only through participation within the games and a willingness to

learn that students will be able pick up the rules and basics of mathematics. A good game engages the learner and invites them to learn through exploration. The game is designed in a way that through exploration the player is constantly learning and moving towards an objective. But this type of learning requires a shift in teaching and the way that students learn math.

This shift does not necessarily reduce the impact of current learning but allows an environment in which students can better learn from themselves and others. It allows students and teachers the ability to utilize Devlin's key feature 5: Trial and error is the best plan. In moving students through a game via their own exploration or with a group they can learn the rules, of mathematics, while engaging these rules and actively practicing them. Throughout the game play, whether the student realizes it or not, they will learn the basic concepts of mathematics in order to solve the puzzle. A teacher and even a textbook can still be used but they are more of helpers or guides rather than the only source of facts and information. Games with others allow students to learn from each other as well as reaffirm what they know by helping others to learn as well. It provides a connection between students that is not as prevalent in a traditional classroom and allows students to teach as well as be taught. A student might not be an expert in the field of math but they can still help their peers towards a collective goal. In doing so it invites all parties, the student being taught, the one doing the teaching, as well anyone listening, to participate in the learning process.

This type of participatory/exploratory learning also invites more interest driven learning because students are not just being shown the rules and told to practice them but

being allowed discern the rules for themselves and see how they work in context. "Interest-driven learning can be a powerful motivator. When passionate about a topic, students willingly read and write texts that are far more complicated than texts about topics they are not passionate about" (Squire, 46). Once a student develops an interest in a given subject they will go outside of the classroom to engage in more learning to create a deeper understanding. As humans people are constantly learning and evolving, even if they are considered an expert, and we have a desire to know more. This interest driven learning is a big part of making game-based learning work.

Kurt Squire has three main points when asked how we can put games into classrooms:

1. Game-based learning environments require a deep commitment to interest driven learning.
2. Game-based learning environments might empower teachers to act as coaches, advisors, and producers rather than as content dispensers and police officers.
3. Game-based learning pedagogies require dedication to design as a worthy goal of education.

Without this commitment to interest driven learning games in a classroom would prove useless because any opportunities to extend learning beyond the game and what is being taught is hampered by standardized tests. Standardized tests focus on memorization of certain topics that should be taught to and thus learned by a student in a specific grade level. Instead of focusing on rote memorization, a student should be able to explore concepts in their own way.

The idea that teachers become more of a guide to students is a new one. In many traditional classrooms the teacher sits at the front and dispenses knowledge to students expecting them to learn and understand everything being taught. The teacher's role in the classroom becomes that of the expert who must share their knowledge while telling students what is right and wrong as well. Through homework and tests the teacher becomes a scary and powerful authority figure and they begin to seem unapproachable. This is not the intention of the teacher but it is a flaw due to the design of a traditional classroom setting. In using a game based approach to learning the teacher becomes the ultimate guide to students as they explore this world of mathematics. The game allows the students to become independent learners in the world given to them to explore and removes the scary authority figure persona from the teacher. The teacher becomes a piece of the world that they are shown and a source of knowledge when the students becomes stuck. Some players will engage the guide, teacher, more than others and it allows for freedom within their own learning. The teacher becomes a resource rather than an obstacle.

Dedication to design is one piece that would be a little harder to understand. In saying dedication to design, what is meant is that there must be a design element open to students so that they can challenge both themselves and others in their understanding of a concept. In allowing the students to engage in this game-based learning a new world is opened to them and they are set loose to explore. But for some exploring is not enough. It goes back to this idea of interest driven learning as well as peer driven learning. For some students, they wish to expand their knowledge and skills beyond what they might have

learned in the classroom. In opening up this design element student can become the teacher. Students can create new levels or design challenges that others can play. They better learn the rules of the world and how they are implemented in a specific challenge. This design provides challenges that students can pose to one another in a way that is not seen as an attack but as fun, friendly competition. Within a mathematics setting it allows the students to better understand a given concept or rule and be able to create their own problem and solution. It gives the student a sense of being involved rather than being a passive learner. Without a dedication to design games would inhibit their own requirement of interest driven learning by telling students that they can only do so much and there is no way to create new challenges or go beyond what was given to them within the game world.

One objection that many people have brought up is that games are unrealistic and do not provide any real application or that they distort reality. Model-based learning is an objection that is often brought up in regards to traditional classroom learning as well because there is no application for the concepts taught once a student leave the classroom setting. In a traditional classroom, especially those that are mathematics based, models are the normal means of learning. In a mathematics classroom models are given in the forms of different problems and challenges that come in homework, projects, and tests. Examples are given to teach students the basics of a mathematical concept and in homework and tests they show their understanding. “Models have to be simplified if they are to be understood- is important for both game design and educators” (Squire, 23). Games are not necessarily based in reality or have any real world applications but are

used as a medium in which to learn the rules that do apply to real life. They are a model that can be created by teachers and expanded by teachers and students in which to learn and understand a concept as well as problem solving techniques that are used in every day life.

In a traditional classroom, modeling through problems is a common occurrence because the student needs to learn the basics of a concept before they are able to apply this skill in a realistic situation. A student must learn the basics of addition and subtraction, through teaching and practice, before they can move into a more realistic environment, such as money management. Even here models are created and built upon in order to help teach a student. Models are simplified to teach a basic concept and then built upon further in order to expand upon the students' knowledge of a concept with the ultimate goal being understanding and real world application of the concept.

Game designers, especially those that create historically based games, accept these simplifications in order to keep the game flow intact as well as keep the game fun and educational. One reason this simplification is necessary is to keep the amount of resources manageable. Simplification also allows the player/student to better see the effects that their choices and actions have on the game world. Once a game/model becomes too involved the player/student can become distracted or frustrated with the intricacies and it becomes less enjoyable and less educational. "Many educators make this mistake (let's include everything so that it's realistic), which makes a model less useful for learning. We don't want a 1:1 map of the world; we want a model to illustrate ideas" (Squire, 23).

Up to now we have discussed features of games and compared them to traditional classroom learning. We have glimpsed what is needed in a game so that it can be used in a classroom. Now we address the question of what makes a good educational game. Criteria given by Kurt Squire are as follows:

"Good educational games employ academic knowledge as a tool for achieving goals.

Good educational games lend themselves to systematic understandings.

Good educational games employ sophisticated game design techniques.

Good educational games offer multiple ways of playing them, so that players can experiment with a variety of identities in a group.

Good educational games pique players' interests.

Good educational games are ideological worlds that instantiate particular ways of viewing and valuing the world.

Good games are social, in that they encourage social interaction of different forms and lead to productive practices.

Good games inspire creativity and smooth ramps to usher players from users to producers" (36-37).

The first criteria that Squire offers is an obvious requirement because a game would not be useful to teachers or students as a learning tool if it failed to provide and employ the academic knowledge found in the classroom and texts. A good educational game provides a learning environment that allows students the opportunity to explore the knowledge they learn and apply this knowledge in within the game world. The student

employs their knowledge and understanding as a tool within the game to perform an action or solve a puzzle while working towards a given goal or set of goals.

A good educational game engages the learner with a set of rules that allows the learner to explore the world that they are given and understand the emergent properties of the world/system. Within mathematics there is a systematic development of learning and understanding that takes place and this must be followed for the learner to build upon different skills in order to achieve the goal(s) set within the game. In following this systematic understanding the game adheres to traditional learning while engaging the learner and fostering interest driven learning.

A game that employs sophisticated design techniques is one that is polished. It takes into account the amount of time a player is willing to spend on a certain activity and designates difficulty of a given puzzle or level in order to keep the player/learner engaged in the material. Overlapping goal structure is another good design technique because it allows the player/learner to see how different concepts can be used together or separately to work towards a goal(s). This overlap also begins to engage the learner in a more real-world application of the basic concepts that they learn both inside and outside of the game world.

Sparking and keeping a player's interest is fundamental to the learning process. A realistic game is not always an important factor for sparking interest in an academic subject. Students need to be engaged within the game rather than being shown every realistic piece of information about a subject. The idea of the game is to learn basic concepts and even critique what might have been different in the real world rather than

becoming lost in the details of the design. Having too many elements, creating something that is too realistic, loses the desired goal of teaching certain concepts in an educational game.

From my research I have developed my own set of criteria for what an educational game needs:

1. Fun, Interest-driven learning that employs competition and challenges as a way to motivate students to learn the underlying rules of the game world.
2. Design element is important for both teachers and students as a way to engage the learners and create a new challenge.
3. Rules are formed by academic knowledge and learned by players to be employed in the simplified model world given to the student.
4. Elements of social interaction through groups or chats in which students can interact to help each other play and learn.
5. Risk is less and feedback is more immediate so that students can see their mistakes and be able to learn why the rules work the way they do rather than memorizing a set of given rules.
6. The teacher must become more of a guide or mentor to the students rather than a police officer strictly enforcing the rules of the classroom.
7. Open, exploratory world allows students to explore the concepts and discover the rules at their own pace.
8. A tracking feature to see what has been completed. Useful for both the student and teacher as a way to track progress and see what they might be missing in order to understand a larger concept as well as assess student progress within the classroom learning outcomes.

The last two criteria were some that I proposed from my own experience with games and how learning happens within a game environment.

Creating an open, exploratory world allows students to explore the concepts and discover the rules of mathematics used within the game at their own pace. Having an open world gameplay allows for students to move through the game at their own pace and also allows for teachers to focus their mentoring on the students that require more guidance. This creates a more well-rounded learning environment within the classroom.

Having an open world gameplay also allows students to move through the game at a faster pace if they feel comfortable doing so. In this respect the students moving at a faster pace are not going to be held back by those that learn at a slower pace because every student is free to explore the game world at their own pace. This type of gameplay also allows students to test their knowledge and see connections between different concepts. If a student tries to solve a puzzle or challenge without the proper tools they can see that they are missing a piece of information. By seeing this missing information they can better understand how the rules of math can be implemented together in order to solve a problem.

We run in to an issue however with our open world format because we lack a way to assess the learning outcomes of the classroom within the game. A tracking feature is needed within the game and provides a way for the teacher to monitor student progress. This feature can help the student as well by showing them what pieces of information they might be missing in order to solve a puzzle/challenge or understand a larger concept. Within this tracking feature the student and teacher should be able to see which challenges they have completed and how the challenges link together into larger concepts. One example of this would be small scattered challenges within the game world that are all related to addition and subtraction and when a challenge is completed, the information of the challenge will then be displayed within the tracking feature. Within a challenge the correct answer will not be automatically displayed so that students can work through solving the problem and find help if needed.

With any feedback given in a classroom setting there is a need for positive and encouraging feedback. Negative feedback can discourage a student from engaging in the learning process. This same fundamental need is applied to any game created to be used as a tool for learning. Positive feedback needs to highlight both the strengths and weaknesses of the students understanding within the game in order for the student to grow in their understanding. In highlighting the strengths of a student, the teachers can reinforce the positive aspects of a student's understanding and progress through certain topics. Showing a student where they need more help, in contrast to their strengths, diminishes the negative affects that come with telling a student where they might have some weaknesses. It also allows the teacher to focus on individual skills for each student when or if they come ask for help with certain tasks or challenges.

Game Analysis

This section looks into four different games in order to better understand how we can begin to create an educational game that satisfies our needs. The first game that I look at is Club Penguin, which was designed with children in mind. It was bought by Disney and is designed for children from 6-14 years of age, which hits on the age range in which students begin to learn basic mathematics concepts. Calculation Nation, in contrast, is designed by the National Council of Teachers of Mathematics and is designed as a beginning step towards educational games as tools to use in the classroom. With the Witness I begin to explore the open world concept for the game that I will propose in the following section. The tracking feature within Assassin's Creed will be the main, and only, focus. While there are limited tracking features in each game that is analyzed in this section the in depth features that are provided with Assassin's Creed II provide a better framework for tracking within an educational game.

Club Penguin:

Club Penguin was created by its founders, Lane Merrifield, Dave Krysko, and Lance Priebe, and was originally released in 2005. “Their goal was to create a safe place where their own children and grandchildren could play, connect and have fun online” (. As a social environment, players can chat with other penguins and play games against them as well. Designed with the safety of their grandchildren in mind, there is also an Online Safety Quiz for players to take and they receive a reward for their penguin upon completion. In their pursuit of internet safety for their players, there are also parent tools that allow the player’s parent to monitor their online activity, set play timers and manage their player’s account.

While Club penguin was designed as a safe social environment for players to gather online the social interaction is somewhat limited. A player can chat through their penguin with others if they choose to do so and there are some games that involve playing against and with other players. They can also make friends with different penguins and are able to see if their friends might be online so that they can play with them. This is not reflective of what is needed within an educational game used as a tool within the classroom but is a good place to start. Having social interaction within a game helps the player to feel more comfortable and even helps them to learn more about the game world and its rules from others. Being able to chat through their penguins as well as play together provides a small piece to this necessary social interaction.

Club Penguin was designed more as a place of play for children rather than to be a place of strict learning, so the game itself is meant to be fun and playful. Each player has

the ability to create and personalize their own penguin, puffle (pet, companion), and igloo. This provides the player with the feeling that they are different in the world and are therefore the “star” within the game. Some aspects of this customization is limited to members only but there is still customization available to those that choose to play Club Penguin without a membership. While the player can customize their own avatar, they cannot design any new levels of any of the mini-games or create different challenges for others to play. In this respect, Club Penguin would be lacking one of the necessary criteria of a good educational game.

Overall the game is fun and the player advances through the story missions because they are interested in them and are motivated to play through them. There are also a large variety of mini-games available for the player to explore. These mini-games range from spy drills to arcade games to making pizzas. The games that involve playing against another player rely on the practice of good sportsmanship to an extent. The player receives rewards for winning the game and so if a player is losing they have the option available to quit if they should choose to do so. Good Sportsmanship within a game implies that no players quit if they are losing or bully a player through chat if they do lose. Games involving more than two players allow for play with multiple friends, and to a single player this can lead to a gang mentality. In saying gang mentality, it is meant to describe the situation where a group of players will team up together to take out another player. The game is designed with fun in mind so there is not much of this present within Club Penguin and each player has the ability to report another if there is any activity that goes against Club Penguin rules.

Within Club Penguin there are different guides available to the player. There are instructions for each mini-game and within the story missions there are different guides that the player has to talk to in order to advance through the story. There are also tour guides available to those that are new to Club Penguin. These tours are given by other players and each tour guide has to pass the Official Club Penguin Tour Guide Test. While this idea is geared more towards the teachers within the classroom some of the ideas are useful. The tour guides, while somewhat superfluous to our idea of a guide, provide the idea that players and peers rather than an expert guide can be used in the correct circumstances. Often trusted peers help to guide a player through a game rather than going to an official guide within the game. Among these peer resources are the many player created walkthroughs and help guides that can be found through a Google or YouTube search. There are also books that are unique to certain places, like the dojo or the EPF (Elite Penguin Force) headquarters, that allow players to learn part of the story lore.

As with almost any game there is also a fan-created wiki that has information on almost any item, game, or story within Club Penguin itself. The validity of the information cannot always be verified as it is a fan-created site and the information can be edited by anyone who accesses the web page. This idea is not unique to one game and is gaining ground within games and other media, including novel series, as a way to contain and categorize the information that fans see as important. As an outside guide, the wiki page has a multitude of helpful information for players to access while they continue to play and explore in Club Penguin. The wiki itself has a search function that allows the

player to find the information that they are looking for to help them as they play. In this way the wiki page, while not verified as a certified, correct source, is able to act as a guide in the way that a teacher using an educational game would need to do. In a classroom using educational games, a teacher would shift to a supporting guide role. A guide that has all the knowledge of the game and rules behind it, just as the wiki does for Club Penguin players.

Within each mini-game the player must follow the rules and learn how each rule is implemented within the game. The instruction guides for the mini-games give the player a general idea of the rules and movements within each game. Each mini-game has a different set of rules and objectives that is unique to the task that they present while the story missions and Card-Jitsu has a more universal set of rules. Within the story missions the player is provided with an initial mission by G, the resident tech penguin, and from there they must interact with their surroundings to solve the mission. There is no defined set of rules for the story missions, but the player is given their map and spy-phone in almost every mission. With these two devices they can access each site that is involved in a particular mission.

For Card-Jitsu there are four separate areas that differ from each-other in the types of mini-games played but hold a standard set of rules that are defined by each guide, or sensei, within the dojo. The rules are somewhat simplistic but require active thought in order to implement them within each mini-game. Each area, outside of the main dojo, is geared towards a separate element, Fire, Water, or Snow. Each of the mini-games within the dojo use the set of cards given to the player, members have access to buy more cards.

The challenge of each area is to earn a suit or belt that your penguin can wear and to eventually understand and become proficient in the game in order to challenge the sensei that is in each area. A player advances through each area by playing against other players that are in the area. Each area provides a different type of game to accompany their element and the rules given to each are available for viewing at any time for the players. After a player beats the sensei of an area they become a ninja, this includes the respective elements (fire ninja, water ninja, and snow ninja). Upon completion of the ninja status they receive a reward from the sensei of the area.

The idea of rules being implemented in a model world for an educational game is similar to that of Card-Jitsu or the story missions. The rules stay the same across the mini-games but are used in different ways. It is this idea that is useful when we think about implementing the rules of mathematics in a model world. Every rule is connected to another in different ways but all are related to the game and implemented within the game world to challenge the player. A model world, such as Card-Jitsu as a small example, allows the player to challenge their understanding of the rules through different given tasks. The idea of the rules being used in different scenarios through the mini-games related to Card-Jitsu is one that will help the player (student) to better understand how the rules of mathematics interact with and build off of each other.

Continuing with Card-Jitsu we can see a small implementation of a tracking feature. A player can track their progress through the different levels as they work towards a different belt color or piece of their elemental suit. They can also view their card deck and see which cards they have available. There is a percentage provided with

each different section of the dojo to track player progress towards completion of the area. Within the penguin menu there is a place for the player to track their stamps for different achievements during activities as well. There is not a lot of tracking available for a player aside from the two mentioned above or different rewards given upon completion but it is a good place to start within a game.

The tracking within the dojo allows a player to see their progress through each area of the dojo separately and monitor how far they are towards receiving different items. This can be useful within an educational game for teachers and students to track progress through a certain area or set of challenges. It is not an ideal set up as it is unique to the way that Club Penguin rewards for the Card-Jitsu progress but can be used as a model for games that have separate areas or sets of challenges.

Within any game world there is little to no risk involved except having to restart a level or losing a life. When a player looses all their lives within a given mini-game they are sent to the rewards page and given the coins and stamps that they earned during the game. In Card-Jitsu a player still makes progress, though smaller the higher the rank (2^{nd}, 3^{rd}, or 4^{th}), and the player can see immediately why they lost a round or the game against other players. The feedback on a loss is immediate because they are removed from the game and in games against other players, the player is shown why they lost. During the story missions players are only allowed to combine items that work together and the player is notified when somethings won't combine or are not helpful in a certain situation. The player is also only allowed to pick up useful items, though they have to find them, and is notified when something will not help them with the mission. During

the mission the player will not be notified if they are missing an item however, or where that item might be. The missions are designed to challenge the player to think about their surroundings and what will be helpful to them within the mission, both information and items.

There is an open world to a certain point within Club Penguin. The player is free to choose which activities to participate in and where to go on within Club Penguin and they are provided with a map in which they can sort places, mini-games, shops, and puffle activities. If the player chooses to attempt a story mission there are certain areas within the mission that they can go while others are blocked off. The story missions reduce the area only to the spots necessary to complete the mission. The openness of Club Penguin allows the players to move through the story and other games at their own pace. This is a good place to start when thinking about an educational game because it allows the students to move at their own pace and engage in different activities if and when they choose to. For an educational game the design is to ultimately reach a certain point of completion and in turn understanding of the concepts at play within the game environment.

Calculation Nation:

"Calculation Nation® is part of the NCTM Illuminations project, which offers Standards-based resources that improve the teaching and learning of mathematics for all students. Its materials illuminate the vision for school mathematics set forth in NCTM's *Principles and Standards for School Mathematics* and *Curriculum Focal Points*" (Calculation Nation). With the educational aspect in mind some of the needed fun was lost. The games themselves are somewhat interesting when the player first encounters them but they do not provide much beyond implementation of the rules in order to draw the player in. Each game provides a different scenario for players to challenge themselves but focus on the applications of mathematics in a way that fails to create interest driven learning. Calculation Nation is designed to target upper elementary and middle school students and help them practice their mathematical concepts in an online game environment.

As an attempt at an educational game, Calculation Nation is a good place to start to see how mathematics content can be implemented in a model environment. Each game uses different concepts from the upper elementary and middle school content level and explains to the player, as well as educators and parents, what concept each game is focused towards. The games themselves apply the rules very well in a simulated environment, proving the player with a way to see how each rule was implemented and how they interact with each other. In looking at a specific game, such as the EQ of Attack, the player must use their knowledge of linear functions to sink ships. Along with sinking ships the player must try to avoid bombs and attempt to hit bonus ships as well.

The bonus ships provide the player with another line and a given condition: using the original line and slope they must translate, rotate, or mirror the line, or they must create a parallel or perpendicular line. The more bonus ships that the player manages to hit the more points they can score. The use of the model world in Calculation Nation is a great example to see how the rules would be implemented for mathematical concepts but just lacks an certain element of fun and interest.

Within each game there are detailed instructions on how to play the game as well as a guide for parents and educators to bring these model games off of their online platform. Looking again at the EQ of Attack, the instructions walk the player through an initial turn, playing against others rather than the computer, so that the student can see how the rules of the game work. While detailed instructions are helpful at times they can also hinder the learning process as well. These instructions provide a very in-depth view of the rules and limit the players ability to explore the rules of the given game/model for themselves. The player is told the rules rather than being able to discover and understand these rules at their own pace. If the player has a hard time understanding the rules of the game they can easily become frustrated and will most likely end up giving up on the game, and in turn understanding the rules and concepts of the game. A smaller, more connected approach would allow students to try different challenges related to larger concepts and help them to understand the concept better before moving onto a larger challenge.

While the games in Calculation Nation can be played against other people there is little to no true social interaction that occurs in Calculation Nation. A player can choose

to play any of the games against another player or against the computer. If the player chooses to play against another player they have to wait for the server to find an opponent and often times the player is the only one playing on Calculation Nation at the time. When another player is found, there is no element of social interaction, such as chat, within the game aside from playing against another player. Caluculaton Nation also lacks any sort of personalization or elements of design. All the games are prebuilt and do not offer the players an option to create their own challenges to show to others.

The set up of Calculation Nation consists of a menu screen where the player can choose for 13 different games and chooses whether to play against another player or to challenge themselves against the computer. Calculation Nation is in no way related to that of an open world game where the player explores the world and encounters different games and challenges as they discover more about the game environment. There is no connecting theme or story to link one game to another and many are not related in any way aside from the mathematical concepts that link the games together. This provides a disjoint feeling to the player (student), and disrupts the flow of a game once a certain task or game is complete.

There is a small tracking feature within Calculation Nation that allows the player to see where the other players that they have played against are from and their total victories. There are many different concepts within each game in Calculation Nation but a limited way to track a players victories for each separate game. Using Calculation Nation as an educational tool can be a good idea but players can stick to one game to earn victories, because total victories are the only tracked information, rather than playing all

games in order to better understand the concepts covered by each game. Expanding this victory tracking to each separate game allows teachers and students to see better where a student might need help in understanding a concept.

Victory tracking however presents an issue within a classroom dynamic. The students begin to compare their victories and for some students the risk of loss is increased by peers. Those that have trouble understanding a concept in a given game begin to fear losing so they avoid the games that present them with this increased risk. In this way students avoid practicing the concepts that are implemented in each specific game and reduce their overall understanding of the concepts being taught within the class. The same idea can be applied to the students that have more victories than others. The student can begin to fear "winning" because of their peers beliefs and action and the student's own fear of being ostracized by their peers. The student can avoid a certain game all together or intentionally fail to practice implementing the concepts at work within the game.

The Witness:

In the Witness, the player starts underground on an abandoned island. The player is initially shown how to operate and solve two simple puzzles. From there they are left with almost no guide to solving the other puzzles and figuring out what happened to the island. The only information that the player is given about the puzzles is how they must start, a larger circle, and where the puzzle will finish, a rounded end that sticks out from the available paths. The puzzles interact with the surroundings and are even made up of the environment, known as environmental puzzles. Left with only the knowledge of how to start and end the puzzles the player is set free onto the island once they are able to complete the first section to open the door.

While there are no in-game guides, there are online guides available to the player at their own discretion. The best online guide for the Witness can be found on Imagine Games Network, or IGN. IGN guides are created and edited by game experts in order to help players navigate different games. The Witness guide provides solutions for every puzzle within the game as well as general tips for those players that do not want to spoil the game. Each section within the guide is organized to match the section on the island that the player is exploring. In addition to puzzle solutions, the guide shows the player where every environmental puzzle is on the island and describe where the player should stand as well as pictures with what the player should be seeing. Overall, this guide is useful when a player gets stuck because it is available, but a player does not have to access this guide as much, if at all, if they are able to solve the puzzles without guidance.

This type of access is helpful within an open world game because it allows the player move through the challenges at their own pace. Some players will move faster than others and some will use the guide while others will choose to go through the game without help. The Island itself is open to the player but as a player explores the puzzles they can begin to see certain patterns and rules at play within different puzzles and areas of the island. As the player explores each of these sections they can see that certain puzzles require knowledge of other rules that have been implemented/explored elsewhere on the island.

It is this type of open world that I believe is the best way to create a game that allows students to explore the rules of mathematics at their own pace. The student can move through puzzles, or challenges, at their own pace and can explore how different rules interact with each other. In this way there is a reduced risk of failure because the player can move to a different area if they become confused or frustrated in their current area. The student also has the option to return to a given challenge when they feel that they have the ability to complete it. No educational game can be completely risk free because the students must complete certain tasks and challenges in order to fulfill the standards and requirements for the classroom.

The Witness is a single player game where the player explores an abandoned island. This type of gameplay limits the social interaction that the player can have within the game. As with most games developed today there is no elements of design available to players; meaning that within the Witness players cannot create their own puzzle. There is however a limited tracking component. A player can see which environmental puzzles

they have found and completed with the six black obelisks that are found around the island. Once an environmental puzzle has been completed it will light up on the nearest obelisk. Once a certain section or area of the island has been completed, there is the possibility of a laser activation. In this respect a player has a limited ability to monitor the sections of the island that they have already completed.

Once a puzzle is complete it will activate another puzzle or set of puzzles. In this way there is a somewhat linear path within each area, but players can still choose to leave an area or come back to it at any time before they complete it. When a player enters an incorrect solution to a puzzle it will simply reset itself and the player can try the puzzle again. Due to a players ability to leave a puzzle whenever they so choose and a minimal risk of failure there is little to no feedback for a player when they fail a puzzle and even when they solve it. While minimal feedback is sometimes a good way to design a challenge, at a lower level positive feedback is needed.

Tracking(Assasin's Creed II):

Assassin's Creed II is a single person game that takes the player through the memories of the ancestor of the protagonist: Ezio Auditore da Firenze. Within the menu screen the player can access a DNA menu, their inventory, a world map, they can view their conspirators, and players can also access a database that contains information on all of the buildings, artifacts, and people that they have come across within the game that have historical significance. It is this model that offers an in depth view of player progress and allows them to review different aspects of their game play. A player can see what they have missed in different sections of the game and teachers can see what sections the student has completed in order to judge game and standards progress.

Within the DNA menu each separate memory is spread out so that the player can track each separate step within a memory as well as see which extras, like feathers and viewpoints, that they are missing. The extras are also broken down by city and within each city are further broken down by sections within each city. The detail and breakdown of the tracking features are needed in order to track student progress in relation to the learning objectives. The depth of explanation used in the database is also helpful for a student to have the ability to access when or if they choose to. An explanation of each larger concept that they have explored and completed would serve as another guide that the student could use as they explore the game further.

A world map would allow students to see where they have explored as well as track where they are going while they play. Within Assassin's Creed II, both large and small tasks are displayed on the map and the player has the ability to create a marker that

they can follow once they leave the map. The ability to see uncompleted tasks displayed allows a student to see where they can go next within the game in order to continue their own learning process. One piece of information that is missing from this detailed tracking is the positive and encouraging feedback for the student. Whether this comes from the teachers themselves or can be generated as an in-game addition it is a necessary component to educational game play.

While information should be available to the student there are certain types of information that need to be separated from the teacher and student tracking. The teacher should have access to information on how many times a student has attempted a certain challenge and where they may have made a mistake if they failed. In this respect their given information would change so that the teachers can better focus the areas that each student needs help in. This will also help a teacher be able to assess student progress with respect to learning outcomes within the classroom as well as view which students choose to engage the game, if they have the ability to do so, outside of the given classroom time. In this way the teacher becomes more of a guide and mentor to students and education can shift away from the enforcer mentality of current traditional classrooms.

Project Mathematica

High Concept

In Project Mathematica, the seven wonders of the Lego® world have been destroyed. The player characters have been contacted by the High council to restore these ancient treasures. They must use their knowledge of Mathematics concepts to solve puzzles and fight adversaries in order to gain the necessary materials for the restoration. Project Mathematica is a third person Lego® action-adventure game with elements of an MMO.

Pitch

License:

Lego®

Player Motivation:

The player is trying to open different customization options for their character, different build options for the design element, and learn the rules of Mathematics throughout the game world. As there are different ways of playing the game they can be motivated to complete the story line, solve the puzzle side-quests, or collect all the different customization and build options.

Genre:

The genre of this game is aimed towards children. As a Lego® adventure game the main genre is an action/adventure but it will also be an MMO with puzzle elements as well.

Target Customer:

The Target customer for this game would be school systems. This game is designed to be a tool for learning within the classroom and thus must be adopted by school systems. This game is also targeted towards children around the ages of 6-14, as it is the children that will be playing the game in order to learn.

Unique selling points:

As the game is geared towards being an in-class learning tool it will have different challenges for different grade levels. There is also a lack of games of this type. There are small-sided games built by mathematics teachers and professors, which are often times

hard or not very fun. Most of these games are designed outside of the classroom for individual use. As a classroom tool this game will open up a new way for children to learn and will be unique with regards to minimal competition in the current market.

Target hardware:

This game is designed for PC/Laptop use as it will be played in classrooms. The student should also be able to bring the game home and should be compatible with all types of Laptops and PCs.

Design Goals:

The game is designed to provide a fun and unique way for students to learn and explore the concepts of mathematics. The players will have the opportunity and ability to create their own challenges that challenge them to explore the rules of the world in a new way. Different design features will unlock for player use as they progress through different story challenges and side quests. The story is designed to make the player the "star" of the game in order to give them the feeling that they are the most important character in the game world. As an MMO, the game also will have unique challenges, outside of the story arc, that require 2-4 players and player cooperation.

Concept

Explanation of the game's genre:

The game will be an action-adventure game that is consistent with past Lego® games. As the game will be played in a classroom setting it will need to be an MMO, Massively Multiplayer Online, game so that data will be stored as players play through the game and work together. The MMO genre is needed so that players can play together within their classroom/grade and so that the data on the players is saved, both for use again as well as evaluation of the student learning outcomes. The designation of action-adventure is somewhat broad. There will be some action, where players can fight NPC's, or Non-playable characters, but these will be limited as the goal is to focus more on the learnable content(the mathematical content) because it is ultimately an educational game.

Game's Premise:

A Lego® person travels through the Lego® world solving math puzzles and collecting studs. The seven wonders of the Lego® world have been destroyed and the player must travel through the world, equipped with their math knowledge, in order to find the materials needed to rebuild them.

Project's scope and learning objectives:

These learning objectives will be pulled from the learning outcomes for a mathematics class for each grade level. Taken from the Common Core States Standard Initiative for a grade 2 mathematics classroom, they are as follows:

In Grade 2, instructional time should focus on four critical areas: (1) extending understanding of base-ten notation; (2) building fluency with addition and subtraction; (3) using standard units of measure; and (4) describing and analyzing shapes.

1) Students extend their understanding of the base-ten system. This includes ideas of counting in fives, tens, and multiples of hundreds, tens, and ones, as well as number relationships involving these units, including comparing. Students understand multi-digit numbers (up to 1000) written in base-ten notation, recognizing that the digits in each place represent amounts of thousands, hundreds, tens, or ones (e.g., 853 is 8 hundreds + 5 tens + 3 ones).
2) Students use their understanding of addition to develop fluency with addition and subtraction within 100. They solve problems within 1000 by applying their understanding of models for addition and subtraction, and they develop, discuss, and use efficient, accurate, and generalizable methods to compute sums and differences of whole numbers in base-ten notation, using their understanding of place value and the properties of operations. They select and accurately apply methods that are appropriate for the context and the numbers involved to mentally calculate sums and differences for numbers with only tens or only hundreds.
3) Students recognize the need for standard units of measure (centimeter and inch) and they use rulers and other measurement tools with the understanding that linear measure involves an iteration of units. They recognize that the smaller the unit, the more iterations they need to cover a given length.

4) Students describe and analyze shapes by examining their sides and angles. Students investigate, describe, and reason about decomposing and combining shapes to make other shapes. Through building, drawing, and analyzing two- and three-dimensional shapes, students develop a foundation for understanding area, volume, congruence, similarity, and symmetry in later grades.

Along with the expanded explanations from the Common Core the learning outcomes would be the guidelines for the main objectives and story mission as well as the side quests within the game.

Description of the target audience:

The target audience for this game is children between the ages of 6-14. It is designed for players learning and practicing their basic mathematics skills. Each Grade levels game will differ in overall content and learning objectives but will maintain similar structure.

Play mechanics and game play description:

Due to the target audience being somewhat young in age the game mechanics cannot be high level. They need to be accessible to and playable for children. The player will create their own character, which they can customize different features. With their character the player will travel through the world(s), as well as a story line, in order to advance the game. The initial guides will help players to learn the mechanics of the game but most of the mechanics will be character movement and interaction without outside objects. There will be some fighting mechanics but should in no way detract from the playability of those at the younger end of the age range. There will be resource

management as well. The players will gather Lego® studs as they progress through the game and will be responsible for spending them as they see fit.

Thematic Concepts:

In choosing a Lego® theme, the idea is to introduce and practice these new concepts in a semi-familiar environment. Most children within this age range are somewhat familiar with the Lego® theme. This could be from a wide range of factors but the familiarity is something to help get the students involved within their learning process.

Description of the game's environment:

Open world environment with player accessible map. This map would open up more as the player discovers more of the world in question. Each section of the world would be geared towards a specific area of concentration, according to the learning outcomes required for the specific grade level. As players progress through certain sections they will eventually see the area concentrations overlap in order to progress player learning and introduce the topics in new ways. As we move through mathematics the topics work together to become increasingly complex. This will be mimicked within the game world in order to help the players/students advance their own understanding of the topics and increase their knowledge. There will also be a space in which players can create their own challenges/levels. It is here that the player will have access to building and they can challenge other players with their levels. Certain features and items will be closed initially but will open up as the player progresses through the game or the become available for purchase using an in game currency.

Development of characters:

Each players Character would be customizable to an extent. They would have to option to choose from male or female for their character, as well as a choice from a number of different races. The player would also be able to customize their skin tone and some bodily features. For the NPCs within the game they will be somewhat random and rather sparse. Some vendors will be available for players to buy items and character customizations. There will also be some in-game guides for the players. These guides will be somewhat limited, especially as the player goes deeper into the game, as the goal is for the players to work together if they need help or reference the teachers outside of the game. Other NPC's that will be in the game are enemies but these will be limited as well to keep player focus on the concepts being taught within the game.

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