In-Game Minecraft Quests for Elementary Education

Tony Morelli Mail
Central Michigan University
1200 S Franklin St, Mt Pleasant, MI 48859
United States

Abstract

As elementary school students become more tech-savvy, they may expect more out of an education presentation. This paper presents methods to modify a popular game, Minecraft, to include educational elements. Two specific modifications demonstrating math concepts were completed and shown to adults. Surveys indicate that Minecraft playing adults feel the additional elements included in these modifications could be beneficial to students.

1. Introduction

The United States has recently introduced the Common Core State Standards Initiative, which is a series of standards to create a consistent learning experience from state to state [15]. These standards lay out learning strategies and topics for English language arts and mathematics. The concepts presented in this paper are an effort to not only adhere to the new standards, but to also demonstrate learning through new tools that students view as entertainment. The approach is based on previous work regarding gaming in education, as well as education in virtual worlds.

The use of gaming in a classroom is not a new topic as it has been around for almost 30 years with the use of Oregon Trail in education as early as 1985. Serious games have been integrated used in the classroom in different ways such as embedded in virtual worlds [13]. It also has been used to compare math learning strategies [10]. The approach in this paper seeks to combine these two schools of thought. The gaming side of education will be done within the game of Minecraft, a sandboxing virtual world game.

Video games have been shown to influence more aggressive behaviors in a study performed by Adachi et al. (2011). However this aggressiveness has been attributed to competition, not violence within the game. The Adachi study found that only changing the violence level of a game had no effect on the aggressive behavior of the player. The aggressiveness increased as competition increased. To consider a game for a classroom environment, any type of competition may introduce an aggressive behavior.

Minecraft [11] is a sandbox game where players build their environment out of blocks. It was originally released in 2010 and has gone on to win numerous gaming awards including three awards at the 2011 Game Developer's Conference (Innovation Award, Best Debut Game and Best Downloadable Game)[18]. It also won the Best Independent Video Game at the 2011 Spike Video Game Awards [9]. Minecraft is currently available on PC/Mac, XBOX 360, Playstation 3 and iOS/Android. Mojang.com self reports total sales of over 50 million units across all platforms through several blog posts updating the total sales for each platform and was recently purchased by Microsoft for $2.5 Billion [14].

Figure 1: In-Game Minecraft Learning

Minecraft has proven to be a popular choice for players to stream live or pre-recorded play sessions on Youtube or Twitch.tv. Particularly skilled players can replicate real world environments within the Minecraft world and share their work through these video streaming sites which results in positive feedback from the community of Minecraft players. This positive environment may contribute to the popularity of the game as good players are reinforced that they are performing at a high level not by score but by feedback from their peers.

Minecraft can also be played through its survival mode. This procedurally generated game is constantly changing and presenting new challenges to players. The game is never repetitive and that may entice players to keep playing. Parents like the game because its focus is on creativity, building, and sharing as opposed to violence against others. In multiplayer mode, players can build social teamwork skills.

2. Minecraft in the classroom

A 2013 Washington Post article [3] investigated the use of Minecraft in the classroom in several areas around the country. Minecraft has been used in the classroom to promote active learning. In a social studies class in Washington, teachers created an environment that mimicked the ancient Roman Empire inside of Minecraft's creative mode. Students were then asked to enter the virtual world and create their own houses based on the types of houses that were built during the Roman Empire. Through this building exercise, students not only learned about what houses looked like, but they actually learned designs and building techniques. Students needed to follow the building process by first sketching out a floor plan by hand, and then following the process to implement the floor plan within the Minecraft world.

In New York City, Minecraft was utilized in a second grade class to teach students about online behavior. Students learned that winning at all costs was not the best behavior and that they could support and help each other while accomplishing tasks within the game. Minecraft has also been used in an after school setting. Most after school programs, such as sports, encourage competition and being better than your peers. Using Minecraft as an after school activity differentiates itself from the standard after school activity in that it promotes cooperation between the students. According to the teacher supervising the after school program, students seem to enjoy using Minecraft as it is a reminder of what they built. In a typical school setting, there is no sense of ownership. But in the Minecraft world, students learn and feel like they own it. They built the world that they learn in.

Minecraftedu.com is a partnership between educators and Mojang to bring Minecraft into the classroom. This special build of Minecraft allows educators to build special worlds for each of their classes and have then run

on isolated server instances. It allows for teachers to act as supervisors while the game is in play and have the ability to mute or unmute students or freeze and unfreeze individual students.

Math has been integrated into the game through the use of a live whiteboard type application. Students who are in the game can see the teacher leave notes in the game such as math problems. Students can see the steps the teacher takes to solve the problem by watching it worked on live on the screen within the virtual world.

Parents have also used Minecraft to demonstrate math concepts to kids [6]. The parent can lay out different blocks that represent concepts such as odd numbers, even numbers, multiplication, and prime numbers. However they are somewhat limiting in that the parent is required to set the world up in the specific way, and then the instruction piece is done verbally by the parent while the child explores the world. Parents have also instructed children to build things such as a fenced in area with a certain area. Students would then build to the specifications, and the supervising adult would be able to tell them whether or not they were correct.

Figure 2: Mathematical Questions to Advance in the World

Another use of Minecraft in education has children building contour maps [7]. A green mountain is built within Minecraft, and the children are instructed to outline each level of height with yellow blocks. Once completed when the student flies above the mountain it looks like a perfect contour map.

Minecraft has been tested with adults [20] where they actively participated in their education. By creating, instead of simply re-stating the learned material, students played through Minecraft and learned techniques such as boolean logic through AND and OR gates. Minecraft has a built in circuit language, redstone, and several programs have used this in an education setting [5, 20].

3. Modification of Minecraft

Minecraft is written in Java, and can be decompiled to reveal the source code. This process has made Minecraft a popular choice for creating modifications to the original game, known as mods. Mods have become popular for players to change their playing experience and environment from the game produced by Mojang. Although the game must be purchased from Mojang, the mods are typically available for free and produced by the gaming

community. Mojang allows the use of mods, and even explains how to install them on their website, however they do mention that mods are not supported by Mojang.

Popular mods include those that have higher texture resolution and are optimized for better performance [17]. Mods such as Mo Creatures [21], Green Thumb [8], and Biomes O Plenty [1] add more animals and other environmental elements to the game. Mods such as Complex [16] and The Dropper 2 [4], allow the player to play through a map that has a start point and an end point along with solving puzzles.

4. Proposed Minecraft in the Classroom

The use of Minecraft in the classroom has primarily been done by having a live teacher involved with students in real time. The approach described in this paper involves learning through Minecraft via in-game concepts (See Figure 1) that do not require a live instructor to be present.

This paper presents two novel contributions to using Minecraft in the classroom. One method introduces the concept of prompting the player in order to break a block, the other concept involves adding quest based problem solving components to single player modes. The modifications were completed using the Forge API [12].

4.1 Prompting in Minecraft

The prompting modification (See Figure 2) will ask the player to correctly answer a question in order to receive credit for the current task. For example, a player might attempt to break a block. After making contact with the block, the player is prompted to answer a math problem. If the answer is correct, the player will continue on with the block breaking as normal, however if the player is incorrect, he will not break the block.

This prompting method can be used to ask players different types of questions throughout the game. For example, if the student is learning math, math questions based on the material the child is learning could be used. A child learning simple subtraction may be asked questions such as 7-5, or 10-3. This style of questions and answers are similar to flash cards but performed in a more interactive way. Students may learn better in this environment as they are entertained and will be given a virtual reward in the game for answering the question correctly. Math is not the only concept that can be presented in this way. Trivia based questions such as history or government may also be presented to the student.

There are a variety of virtual rewards that can be given in this style of play, however the rewards suggested here are immediate rewards based on the actions of the player. Breaking a block may not be performed unless the question is answered correctly. A special power up item may be behind a hidden door, however in order to open the door the player must answer a prompted question correctly.

4.2 In Game Quests

A modification adding quests consistent with common core math requirements tasks players with quantifying situations found within the game (See Figure 3). The premise for this modification is evolved from examples provided by the National Library of Virtual Manipulatives (NLVM) [19]. The NLVM is an NSF funded project that began in 1999 with the purpose of creating interactive tutorials for math instruction. The site provides examples that run on Java within a web browser, and one of the examples provided was created within the Minecraft game to provide an interactive method to build bar graphs. Players using this mod, are required to count the number of different animals (See Figure 3) and then display the counts of each type of animal by

manipulating an in game bar graph. The player must visit each of the four pens containing animals, and then visit the bar graph. The player can then manipulate each of the four bars of the graph representing the animals until each of the bars contains the desired count of animals. When the player has finished manipulating the bar graphs, he can then return to the control area where he can press a button to check his work. If the bar graph values do not correctly represent the number of animals in each pen, nothing happens and the player has the opportunity to revisit the pens and modify the bar charts. Once the correct answer is obtained, the player is rewarded with an in game firework display.

Figure 3: In world task to count 4 pigs and 3 cows

5. User Survey

To examine the potential benefits and uses of these proposed modifications to Minecraft, a survey was performed. Users were recruited anonymously via an online survey and all data contained was self reported. Because of the independent nature of this survey, some participants chose to not answer all questions. Where there was a lack of participation, it is noted in the results description. 60 adults over the age of 18 (Average age 24 years, SD=7.36) where shown a short two minute video clip that demonstrated the concepts described for each of the two methods described in this paper. At the conclusion of the video, participants were asked to complete a short survey. The survey and its results are described in this section. Adult Minecraft players were chosen for the survey as they have knowledge of both education and the game, which should allow them to answer honestly about how Minecraft can be enhanced with learning objectives without ruining the overall gameplay experience.

Participants were asked how often they personally played Minecraft. 61% of participants reported playing Minecraft on a daily basis, 30% reported playing Minecraft on a weekly basis, and 1% of the respondents reported playing Minecraft on a yearly basis. No participant in the survey reported not playing Minecraft at all in the past year. When asked how often the participant in the survey played a game of Minecraft with a child under the age of 18, 42% reported playing the game with a child on a daily basis, 34% reported playing the game with a child on a weekly basis, 5% reported playing the game on a monthly basis, 0 participants reported

playing a game of Minecraft with a minor on a yearly basis, and 20% reported never playing a game of Minecraft with a minor.

Participants in the survey were asked to rate statements based on the following scale:

(1) - Strongly Disagree
(2) - Disagree
(3) - Neither Disagree or Agree
(4) - Agree
(5) - Strongly Agree

The following statements were posed to the participants:

(1) Children will learn math when it is integrated with Minecraft.
(2) It will be easier for children to learn math when it is integrated with Minecraft as Compared with traditional school based learning.
(3) Children will learn subjects other than math if they are integrated with Minecraft.
(4) The video showing an integrated bar graph will help children understand math Concepts.
(5) The video showing a math problem as a result of block breaking will help children Understand math concepts.
(6) The video showing a math problem as a result of block breaking is a suitable Replacement for flash cards.
(7) Schools should use learning integrated with Minecraft in grades 1-5.
(8) Examples similar to those shown in the video are a practical alternative for homework Assignments.
(9) Students would be more likely to complete homework assignments if they were integrated into Minecraft.
(10) Students would be more willing to complete homework assignments if they were Integrated into Minecraft.
(11) The implementation of the concepts shown in the video are unique.

The results of this study are shown in Table 1.

Question	Strongly Disagree	Disagree	Neither Agree or Disagree	Agree	Strongly Agree	Average
1	3	4	7	32	14	3.83
2	3	4	16	18	19	3.77
3	1	3	5	37	14	4.00
4	3	7	11	28	11	3.62
5	3	9	10	22	16	3.65
6	4	7	12	23	14	3.60
7	2	8	13	24	13	3.63
8	6	8	13	26	7	3.33
9	2	4	5	21	28	4.15
10	2	2	5	17	34	4.32
11	2	3	10	30	15	3.88

Table 1: Responses from user survey

Overall, the results show strong interest in these types of modifications to Minecraft. Over 60% of the respondents in the survey either selecting Agree or Strongly Agree on 10 out of the 11 questions. The exception to this was question 8. Question 8, which asks whether or not these mods could be used as a homework alternative, only contained 55% of the respondents selecting Agree or Strongly Agree. This type of positive response is indicative that this work is going in the right direction.

6. Future Work

The modifications suggested in this paper are a starting point for unsupervised learning within the game of Minecraft. The future of these mods could be to complete them in such a way that educational leaders may use them in the classroom. In order to do this successfully, the flash card modification may benefit from additional features. The math problems could get progressively harder as the student achieves success at lower levels. This would allow the game to adapt to the student's abilities. Another change would be to allow the scripting of questions and answers. This could promote flash card style learning for all types of subjects. While providing the question and answer section to students could promote learning by itself, logging what the student did, and that he was successful or unsuccessful would need to be added so the instructor would be able to confirm completion of the assignment.

The results of the survey indicate there is a strong belief from adults who play Minecraft that students could benefit from learning through playing the game. This belief needs to be followed up with a long-term user study involving students. It is possible that students may not want to learn through Minecraft, however a longer-term user study with elementary school students will demonstrate the importance of integrating this type of learning into the curriculum.

7. Conclusion

This paper presented two different educational modifications to the popular game Minecraft. The modifications demonstrated math concepts and reinforced repetitive learning techniques by providing fun quests and requirements to answer questions in order to progress through the game. A user survey of 60 adult Minecraft players indicate a strong belief that these techniques will be beneficial to students.

8. References

[1] Adubbz. (2014). BiomesOPlenty. http://files.minecraftforge.net/BiomesOPlenty. May 10, 2014. Retrieved 5/10/2014.

[2] Adachi, Paul J. C. & Willoughby, Teena (2011). The Effect of Video Game Competition and Violence on Aggressive Behavior: Which Characteristic Has the Greatest Influence?. American Psychological Association 2011, Vol. 1, No. 4, Pages 259–274. Psychology of Violence 2011.

[3] Barron, Christina (2013). Minecraft spawns classroom lessons. http://www.washingtonpost.com/lifestyle/kidspost/minecraft-spawns-classroom-lessons/2013/03/14/717aed66-87b8-11e2-98a3-b3db6b9ac586_story.html. March 3, 2013. Retrieved 5/12/2014.

[4] Bigre (2013). ADV/PUZZ THE DROPPER 2; Newton VS Darwin http://www.planetminecraft.com/project/the-dropper-2-newton-vs-darwin. May 18, 2013. Retrieved 5/20/2014.

[5] Catete, Veronica & Wassell, Kathleen & Barnes, Tiffany (2014). Use and Development of

Entertainment Technologies in After School STEM Program. SIGCSE '14 Proceedings of the 45th ACM technical symposium on Computer science education. Pages 163-168. ACM New York, NY, USA 2014.

[6] Connell, Michael W (2013). Teaching Math With Minecraft (an Education Experiment). http://theeducationscientist.blogspot.com/2013/08/teaching-math-with-minecraft-impromptu.html. August 26, 2013. Retrieved 5/10/2014.

[7] Elford, Stephen (2012). Thinking in 3 Dimensions is HARD!. http://minecrafteduelfie.blogspot.com/2012/01/thinking-in-3-dimensions-is-hard.html. January 12, 2012. Retrieved 5/10/2014.

[8] Enosphorous (2013). GREEN THUMB - NATURE OVERHAUL. http://www.minecraftforum.net/topic/1796824-discontinued-5-languages-mc-16x-mod-v014-green-thumb-nature-overhaul. May 4, 2013. Retreived 5/12/2014.

[9] Grant, Christopher (2011). Here are the winners of the 2011 Spike Video Game Awards. http://www.joystiq.com/2011/12/10/here-are-the-winners-of-the-2011-spike-video-game-awards/. Dec 10th 2011. Retrieved 5/12/2014.

[10] Ke, Feng (2006). Classroom goal structures for educational math game application ICLS '06 Proceedings of the 7th international conference on Learning sciences Pages 314-320. International Society of the Learning Sciences 2006.

[11] Minecraft (2015). https://minecraft.net/. Mojang 2009-2014. Retrieved 1/20/2015.

[12] MinecraftForge (2015). http://www.minecraftforge.net. Retrieved 1/21/2015.

[13] Monroy, Carlos, & Klisch, Yvonne & Miller, Leslie M 2011). Emerging contexts for science education: embedding a forensic science game in a virtual world}. iConference '11 Proceedings of the 2011 iConference Pages 622-629. ACM New York, NY, USA 2011.

[14] Mojang (2014). Yes We are Being Bought By Microsoft. https://mojang.com/2014/09/yes-were-being-bought-by-microsoft/. Retrieved 1/25/2015.

[15] The NGA Center for Best Practices (NGA Center) and the Council of Chief State School Officers (CCSSO) (2014). Common Core Standards Initiative, http://www.corestandards.org. Retrieved 5/15/2014.

[16] Qmagnet (2013). Complex (Single Player Version). http://www.curse.com/worlds/minecraft/complex-single-player-version. December 31, 2013. Retrieved 5/10/2014.

[17] sp614x (2012). OptiFine Chasing the Minecraft Performance. http://optifog.blogspot.com. March 1, 2012. Retrieved 5/10/2014.

[18] UBM Tech (2014). Game Developers Choice Awards, http://www.gamechoiceawards.com/archive/gdca_11th.html. Retrieved 5/5/2014.

[19] Utah State University (2014). The National Library of Virtual Manipulatives (NLVM)}. http://nlvm.usu.edu. 1999-2014. Retrieved 4/1/2014.

[20] Wingrave, Chadwick & Norton, Juliet & Ross, Christopher & Ochoa, Nathan & Veazanchin, Sergiu & Charbonneau, Emiko & LaViola, Joseph (2012). Inspiring Creative Constructivist Play. CHI EA '12. CHI '12 Extended Abstracts on Human Factors in Computing Systems Pages 2339-2344 ACM New York, NY, USA 2012.

[21] Zhark, Dr (2014). Dr. Zhark's Official MoCreatures. http://mocreatures.org. May 2, 2014. Retrieved 5/10/2014.