Minecraft: A Game as an Education and Scientific Learning Tool

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ABSTRACT

Games are not just played; they are talked about, read about, fantasized about, altered, and become models for everyday life. This had raised much controversy on how and what if video games used an educational tool. Some players and developers argue that video games are better at teaching logic and problem solving skills than many school curriculums. Some game has adopted aspects that are defined to be similar or base on scientific implementation. Minecraft is one of the games with such aspects. It is a java multiplayer sandbox game where player is required to gather object to create environment around it at will. With functioning ecology, chemistry and physics aspects integrated within the game, these aspects can be used as development media for scientific concept to be used as learning tool for players. The article contains reviews on aspects to be used for learning in Minecraft that can be integrated as a wondrous teaching media on scientific and social aspects in real case studies. By adopting Minecraft in education it will benefit the education by the use entertainment aspect of the game which will create enjoyment in learning itself.

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1. INTRODUCTION

The Game has been on our culture since the old times. Modernizations of technology evolve gaming to electronic gizmo, implementation since then are mostly based on pc, console games to mobile smart phone games, games are moved to screen based apparatus. Despite it age has been much younger than other entertainment apparatus [3] video games have become mainstream existence of entertainment. People nature as the *21th century learner* obtained a paradigm shift toward digital base apparatus, which digital technologies are pervasive [11]. This make games today is more than an entertainment media, games are not just played; they are talked about, read about, fantasized about, cheated at, altered, and become models for everyday life. It alters our formation of subjectivity and intersubjectivity [3, 9]. This raised much controversy on how and what if video games used an educational tool. Some players and developers argue that video games are better at teaching logic and problem solving skills than many school curriculums [1]. In the contrary whilst most game targeted toward more mature target market development where violence or any other non-supporting asset mostly occurred. Popular games like first person shooter or action role playing games contain some degree of violence as part of its approach of entertainment which makes it certainly unsuitable for education environment.

Games are most likely to use as entertainment tools rather than academic [4]. This raised much controversy between to use games as an educational tool. Most of video games targeted for more mature audience which not suitable for learning environment [2]. Most development of educational game is either hasty or unprepared producing bad quality games [5]. However some indie video games developer nowadays have realize a change in market which moving toward general audience. Even that most of these developers were not as big renown as commercial game company, their creation is most creative and unique, and some

new idea of game creation even developed to make their game stands from commercial gaming developers. Some of the game involves aspect that is defined to be similar as a real world aspect but in different way of viewing.

One of the games that follow similar style of development is Minecraft. It follows principle of earth ecology to produce and generate an in game environment. Similar to LEGO bricks, player can pick or place each block at will. Each of the objects and items in game represented with blocky style object, placed in semi random way to create a representation of real world environment. The game requires creativity and logic to proceed yet with addictive gameplay, Minecraft is a suitable candidate to be used as an education or scientific learning tools.

2. LITERATURE REVIEW

Minecraft is a java base first person multiplayer sandbox game. Categorized as virtual world game, Minecraft is a game about placing blocks [8], where player is requires gathering object to create environment around it at will. Minecraft is a game that created and published by Mojang, an indie game Developer Company on 2009 for home computer and later the mobile version for iOS and android in 2012. Over 11 million copies have been sold since the pc release [8] which makes it one of the most popular sandbox games in the world. Minecraft primary objective of the game is to survive in random generated environments from numerous amounts of enemies that spawned in night cycle of the game from day-night cycle implemented in the game, player needs to create shelter and tools for their survival with traps or weapons. Materials such as irons, gold, or diamond can be used to create stronger tools; these can be obtained from exploring caves or creating a mine. This is registered as *'survival mode'* game mode which is the vanilla mode of the game. The other game mode is *'creative mode'* where the player can focus on construction, building structure or any object in mind. Minecraft became quickly viral due it is a virtual world sandbox game; there is no actual objective defined at all. Despite the needs to survive, players is free to create their own mission and sets of objective, either to complete basic needs or more complicated objective giving everyone freedom on how to complete it which give it addictive nature on its gameplay rather than graphics.

Figure 1. Player created castle in Minecraft

Minecraft mechanics and features give it challenge which player can complete it with their own way. With multiplayer experience player can coordinate to create wondrous feats such as a replica of famous building or places.

As a player, Minecraft works by collecting, breaking, reconstruct, and placing object represented by blocks placed in random generated environment ,which player require to place to create structure or any other objects by placing block by block by the of the game constrain and creativity. These environment created by sets of object that visualize the real life environment (trees, grass, etc), determined by each of semi random placement of biomes that represent multiple environment in the world (snowy, dessert, swamp). In process of world generation, Minecraft uses biome system to create sets of visualization to the player as the representation of the world. Each of this biome data contains information of sets of blocks to be use and how should it place. This information are closely resemble to earth environment, for example a dessert with sands and cactus, a jungle with tall trees. These biomes are represented on Minecraft as a blueprint to generate the visualization mentioned above, it control placement of the object, on how should it be place to create the representation.

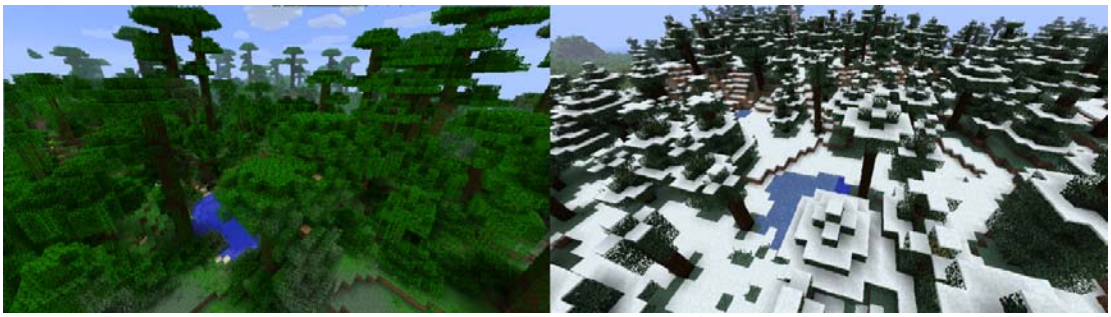

Figure 2. Ecology visualizations in Minecraft. Jungle biome (left) and snowy biome (right).

Despite the imaginative enemies, Minecraft also adopt representation of Real-world animal, this include cows, pigs, sheep, wolves, chicken, cats and newly added horses. These animals have significant role in gameplay by providing many various use, either it providing food source, protection, transportation or other crucial items which is required to craft some other items. Minecraft allow animal taming and breeding by the use of food or any other items that can be obtain by various way, for example wheat that require player to grow them from seed.

There are many aspects in Minecraft which can be transformed to be a fun yet effective teaching tool. With exploitation of these aspects, Educational institution around the world had starting to adopt the usage of Minecraft as a teaching tool. Minecraftedu for example, is a community of teachers and professors that uses Minecraft as a teaching tool that develop Minecraft to be specialized to be used for classroom environment. With a right way of creating an appropriate environment and teaching technique, game aspects of Minecraft can be used to reconstruct a study mechanic that can be archive in real world cases.

3. USING MINECRAFT AS TOOL IN EDUCATION

Minecraft is an openly free formed game, an implementation of a working classroom workflow will require educator to learn on how to create the flow of the task and objective for which students will be assigned for or how to teach student with it. However either educator or student will require some degree of expertise of game command and mechanics to perform these tasks, especially in multiplayer environment of Minecraft. This however can be mitigated by using modification in the game. Some Minecraft educator community has prepared these modifications ready for use to other. One of these modification can be sampled from *mincraftedu*, which provide a custom Minecraft modification for more easy to use, expansive tutorial about the game, each of use and many other supplementing factors.

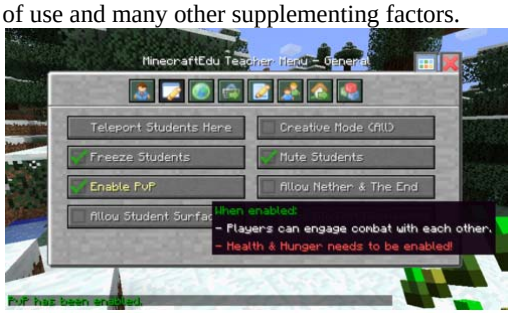

Figure 3. Modified Minecraft client from MinecraftEdu[12], providing push-button management

a. Minecraft as an ecology learning tools

As mentioned at chapter 2, Minecraft implement biome system. Take example on biomes and terrain generation system in the game. Each of plots of lands in Minecraft can be used as fundamental teaching tools for ecology and geology due to its nature that is created to be resembled of real world environment. The blocks generated and placed by the code to replicate steppe, dessert, forest, ocean and any other area. Logic of the nature object such as trees, corps and grass also follows implementation of real organism, tree require enough light, water and space to grow, sugar canes require to be grown near water, tree growth on shape an height follow biomes, etc. An educator can take advantage of this feature to simulate ecological studies.

Figure 4. Farming mechanic in Minecraft. Crops require to be placed near water to grow

By creating a case study in the field, educator can create a certain environment to perform studying process in the environment. Student logic, knowledge and creativity will be certainly stimulated on solving the problem in the study case. For example a simple food chain case study can be performed by placing sheep spawned in an enclosure and ask the student to control the animal population with their idea to preserve grass covered area.

Figure 5. Use of case study in Minecraft. Sheep population explosion in the enclosure occurred, how you will excess with this problem.

b. Minecraft as scientific learning tools

The main features of Minecraft are the ability of player to destroy, collect and place almost every object in game at the environment at will. This crucial feature could be exploited and adopted as an education tools. By creating a certain object to represent certain object in the topic, education processes can be performed by using these objects as a presentation. For example, Minecraft can be used to create a fibonaci spiral, to a working replica of neuron using Minecraft redstone mechanic.

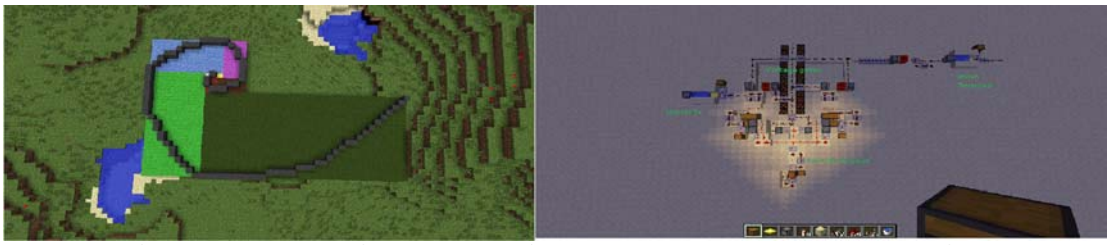

Figure 6. Scientific visualization in Minecraft. Fibonaci spiral (left), and a working neuron replica (right) by Minecraft player.

Redstone is one of features implemented in Minecraft. Originally, this feature was used to extend range of signal from activator object such as button or lever to mechanical objects such as piston or doors. However Redstone mechanic follows principles of gate logic that is implemented in circuitry (such logic gate, or, xor, nor circuit). This feature is exploitable to create a degree of programming a circuit making inside the game. People have manage to make a working computer (CPU,ALU,GPU,RAM) inside the game, which able to run a mathematical calculation function to a game by itself.

This interesting mechanics works like a cable, however it is used to transport signal rather than electricity, and it also has limited range of transmission. Each signal can be transmitted by either Redstone torch or activation object such as lever, pressure plate, or button. These signals are used to activate object

which require signal from distance. The usage of redstone is simple and user friendly for even new players, it require placement on the ground to create a track to connect to a signal source. Each track can be extended up to 16 blocks before losing power; it will require a repeater to extend the range. Redstone track can be arranged to certain logic gate which can be implemented in integrated autonomous system to work as the player desire. This logic gate implementation can be interpreted to follows the logic of the truth table. Using the implementation of gate logic in Minecraft, it is viable that redstone circuit to create a function replica of simple electronic appliance such as calculator, some people have manage to create a computer and 3d printer with increment of java virtual memory.

The possibility of creation is almost limitless (bounded by the game mechanic and physic). With the use of redstone circuitry, a way of teaching fundamental electrical engineering can be applied. Implementation of logic gate with signal to control either mechanical (moving the block object) or the signal type output itself can be used to create simple to advanced circuitry for the use of electronic appliance. An example of the advanced appliance created in game is the redgame computer, a working computer with computing power that is enough to run 2d game, the computer solely created by usage of redstone and mechanical features in Minecraft.

3.2. Minecraft as cultural and social learning tool

Minecraft capability allows almost limitless creation of replica of many wondrous structures. Minecraft player have archived such feat by replicating many structure from major movies or important structure. It is possible that Minecraft to be used to replicate historic place and event to further immerse student in process of their studies. This function also could be benefitted in use for architecture learning media due the fact that Minecraft is a sandbox style games. By controlled multiplayer immersion, Minecraft can be used as a social leaning tool. Creation of case studies for scenarios in real world such as bank simulation or citizenship appliance procedure. Student will benefits significantly due to fact that they learn using game, which their learning process stimulated by fun.

4. CONCLUSION

Usage of video game in education is supported by other uses of media in teaching. Think of it as a tool, usage of games is another media to be added to the inventory. Virtual world and simulation can benefit traditional teaching method, in fact it have been increasingly used. Minecraft as a creation sandbox game have almost limitless capability to represent one's creativity. It has been used throughout the world to represent scientific concept throughout the world. As mentioned on chapter 3, Minecraft features have the capability if usage as a tool to benefit the learning process in scientific or social way.

Table 1. Features and its function on Minecraft

Features	**function**
Biomes	Ecology
Redstone	Electrical engineering, computer science
Breaking and placing block	Cultural architecture, dimension orientation
multiplayer	Social learning

As shown in table 1, features of Minecraft can be used for learning purposes accordingly. However a Minecraft world can be designed and fabricated by player to *illustrate a creation about everything*. Many Minecraft users have represented their idea, as a scientific proof and concept or either as educational entertainment. As an educator, Minecraft world *can be fabricated at will to fulfill an environment which has positive effects to students learning process*. Creation on series of lesson or studies based on these ideas can benefit to the student as exposing them to real world case study.The game contains amazing opportunities for development in field of scientific education. Minecraft capable more than what is taken as examples in this article, it still can be further improved. Despite the game limitations, possibility of usage in educational field education is limitless.

REFERENCES

[1] M. Carbonaro et al., "Adapting a commercial role-playing game for educational computer game production," Proc. 2nd Int. North American Simulation and AI in Computer Games Conf. (GAME'ONNA' 2006), pp. 54- 61, September 2006.

[2] A. Leonard, "Video Games in Education: Why They Should Be Used and How They Are Being Used," Theory Into Practice, Vol. 47, Iss. 3, July 2008

[3] *Scot who invented TV*, 10 February 2010, www.thesun.co.uk, 09 july 2013
[4] *Unavoidable Ethical Questions about Video Gaming*. Nov 2005. http://www.scu.edu/ethics/publications/submitted/video-games.html, 07 July 2013
[5] S. Tim, *why education game fail*. October 18, 2010 http://etcjournal.com/2010/10/18/why-educational-games-fail/. 07 July 2013
[6] *4 Excellent Indie Games with Real Educational Value*, august 06 2011, http://mashable.com/2011/08/06/indie-games-education/. 07 july 2013
[7] N. Rick, *Using Video Games As a Stealth Teaching Tool*, 17 February 2011. http://psychcentral.com/news/2011/02/17/using-video-games-as-a-stealth-teaching-tool/23615.html, 07 July 2013
[8] Mojang, *Minecraft is a game about placing blocks*. http://Minecraft.net/, 28 June 2013
[9] James Paul Gee (2004) *What Video Games Have to Teach Us About Learning and Literacy*, Palgrave Macmillan.
[10] Y. Timothy, Red Stone Circuit Workshop May 17, 2013. http://clrn.dmlhub.net/content/red-stone-circuit-workshop. 07 July 2013
[11] Leonard A. Annetta (2008) *Serious Educational Games: From Theory to Practice*, Sense Publishers p13, 2008.
[12] *Why Minecraft?*, MinecraftEdu, http://Minecraftedu.com/page/, 09 June 2013.

BIBLIOGRAPHY OF AUTHORS

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Currently working as a programmer at Siloam Hospital Lippo he is also an active member of Minecraft community and as moderator at few Minecraft servers.

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