‘Gamified’ Technology Supported Project Based Learning + Student Habits of Mind
Leveraging Aspects of Games Like MinecraftEdu in Order To Achieve
Something Beyond Traditional Project Based Learning.

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Purpose & Significance

Most gamification concepts fail to improve student learning behaviors due to poor alignment with gamification objectives. Virtual worlds like Minecraft act as zones where students can explore, design and problem solve. The further examination of students’ intrinsic motivation for learning and habits of mind through participation in ‘gamified’ technology-supported project based learning could yield insight for future educators. Project based learning occurs when students develop real-world solutions to global problems. The purpose of this study is to determine how students use the MinecraftEdu game in order to synchronously demonstrate solutions to project questions, discover gamification elements that influence student habits of mind and learning behaviors like perseverance, taking educated risks and imaginative thinking and determine how the study of game mechanics can provide a better understanding of gamification for learning. Therefore the research questions for this study are:

1. How do virtual worlds like MinecraftEdu act as zones where students can explore, design and problem solve?

2. How do gamification concepts improve student learning behaviors and align with gamification objectives?
Conceptual Framework

The conceptual framework for this study includes a review of three literature sources. Each literature source reinforces the scholarly significance of gamification in education, game mechanics, teaching and learning in virtual worlds and their influence upon student learning behaviors and intrinsic motivation for learning.

Exploring The Application, Attitudes and Integration of Video Games In Middle School

The first literature source is grounded in Lopez’s et.al (2015) research about the use of MinecraftEdu in classroom practice and analyzes the outcomes and attitudes of all members of the educational community regarding the implementation of video games in formal education. It is important to contextually associate the value of educational research to provide findings that help to determine whether it is advisable to adopt goals and encourage learning activities that are meaningful and motivating for students using virtual tools in various curricular disciplines (Lopez et.al, 2015, p.114). The study postulates that teenagers’ intrinsic motivation towards games contrasts with their often-noted lack of interest in curricular content. The most important features of game-based learning are related to the fact that they are educational and they allow interaction in the virtual environment. In these environments, players are part of the learning environment, as decisions directly affect the course of the game. The general trends in research indicate an increasing popularity among students using game-based learning integrated into the objectives of the curriculum (Lopez et.al, 2015, p.114). Most of the participants in the study thought that MinecraftEdu enhances creativity (96.1%), improves learning (83.4%), is fun (98.5 %), enables discovery (96.6%) and facilitates learning of historical content (97.1%) (Items 1, 2, 3, 5 and 6; under the section Dimension 2: Attitudes of parents, teachers and students regarding the use of MinecraftEdu in education, Figure 5). Nevertheless, there is a consensus and a majority agreement by the entire school community that recognizes the pedagogical benefits of MinecraftEdu (Table 4, Figure 5) due to several advantages that most participants highlighted.
Students are in full agreement with this approach, mainly because of the fun and dynamic classes that allow them to be active protagonists who discover and develop contents and creativity in an immersive world (Lopez et.al, 2015, p.125-126).

**Using Game Worlds in Cyberspace for Communicating Educational Content** The second literature source is grounded in Araki & Carliner’s (2008) study of key issues in using virtual worlds to communicate technical and learning content. Araki & Carliner (2008) postulate that virtual worlds are persistent online environments in which several users simultaneously interact with one another through a digital character that represents them. This character is called an avatar (p.251). It is important to contextually associate the impact game worlds can have upon social learning that occurs in technology-supported project based learning units. Although many virtual worlds are designed for entertainment purposes, users are finding many ways to integrate them into professional and learning activities. Both game worlds and social worlds share common characteristics like:

- Shared spaces where users share the same environment
- Immediacy where user interaction happens in real time
- Interactivity where users interact with other users, non-player characters and the content in the virtual world

Further research into issues creating and communicating content in virtual worlds should include instructional design for content creation, including tools for creating, managing and sharing content, learning to use the tools and the re-use of content from outside the virtual world. One solution Araki and Carliner (2008) offer is letting users experience technical and learning content through the collaborative design spaces they offer (Araki & Carliner, 2008, p.255-256). Additionally, as students collaborate with one another in technology-supported project based learning units, it is critical to explore the use of student groups in virtual worlds. According to Araki & Carliner (2008), joining a group is necessary for success in game worlds because
advancement to higher levels requires different types of characters (students) to share valuable information, resources and skills (p.256).

**Gamification in Education: A Systematic Mapping Study** The third literature source is grounded in Dicheva’s et.al, (2015) research about gamification and its application in education as an emergent trend. Dicheva et.al (2015) postulates that extrinsic and intrinsic motivation of the learners can be influenced by gamification. According to Dicheva et.al (2015) the gamification approach suggests using game thinking and game design elements to improve learners’ engagement and motivation. Games have remarkable motivational power; they utilize a number of mechanisms to encourage people to engage with them, often without any reward, just for the joy of playing and the possibility to win (p. 75). In recent years, gamification has seen rapid adoption in business, marketing, corporate management, and wellness and ecology initiatives. This is driven by its potential to shape users’ behavior in a desirable direction. Traditional computer game theorists, categorize game elements into mechanics, dynamics, and aesthetics. Mechanics define the way games (as systems) convert specific inputs into specific outputs. Dynamics guide how players and the game mechanics interact during the game. Aesthetics refer to the way the game mechanics and dynamics interact with the game designer’s artistry, to produce cultural and emotional outcomes (p.77). Further research into how the most used gamification design principles in educational contexts like visual status, social engagement, freedom of choice, freedom to fail, and rapid feedback can reveal unique influences upon the application of this emerging technology in education (Dicheva et.al, 2015, p.88). Further research into the mechanized nature of ‘gamified’ learning experiences can provide valuable insight into how student inputs yield specific outputs that reflect learning habits of mind in the instructional environment.
Method

This study follows methods governed by the University of Florida Lastinger Center for Learning. The center creates educational models that push the boundaries of teaching and learning. It is the goal of the University of Florida Lastinger Center for Learning to create, field test and disseminate innovations that transform teaching, improving learning and promote healthy child development (University of Florida, 2016). Both the University of Florida Lastinger Center for Learning and local school administration support the Teacher Action Research Inquiry Process that precipitates this study, findings and conclusions.

Four sixth grade students were selected to participate in the study focused on the science curriculum. The study consisted of one female student and three male students. Although four students and their experiences were analyzed for the purposes of this study, all students enrolled in the sixth grade science classroom participated in the technology-supported project based learning unit. Learning occurred in a blended environment, where instructional practices like lecture were used in addition to technologies like the game of MinecraftEdu. As students learned about farming and sustainability, progressive learning behaviors allowed players to demonstrate strategic actions in order to build, test and hypothesize scientific concepts in a collaborative, communicative and goal driven world.
Overview of Technology-Supported Project Based Learning Unit

The Technology-Supported Project Based Learning Unit focused on farming and sustainability. Students worked collaboratively in order to develop an “urbanized” and self-sustainable farming world. In MinecraftEdu, the students are able to use blocks in order to build and conceptualize scientific models (See Figure 1.0).

Figure 1.0: Students use a variety of building blocks and materials to design and build their products.

Source: http://goo.gl/aOw4Dk

First students designed processes to plant, water and sustain crops. Students started in MinecraftEdu with a blank/flat world. Students learned about the Earth’s interior layers. Instruction focused upon the crust and the students were able to claim a plot of land, cultivate the land (turn the earth into farm ready soil) and develop irrigation systems in order to help the land get the nutrients and water necessary to survive. Students worked to develop different farming
plot designs and irrigation system designs in order to use the most amount of land that could yield crops and the least amount of water in an effort to be mindful of our access to water.

Next, students were able to explore weathering, erosion and deposition. Students observed that mechanical and chemical weathering could occur in a farm due to natural causes like rain and lightning (See Figure 2.0). Seeds planted by students could be moved by wind, water or animals and be deposited in new locations, causing their farms to lose viable crops. Students designed systems to protect their crops from natural causes that could weather, erode and deposit seeds in different locations than intended.

Figure 2.0: Students are able to understand how natural causes like rain, water movement, lightning and animals can cause seeds to break down, travel and move to new, undesired locations within the game.

Source: http://goo.gl/7Fmr9a
Next, students learned about landforms. Students were able to understand how landforms can protect and/or destroy farms. Students were tasked with developing hills in order to protect farms from wind and they also developed river systems that could feed into irrigation systems (See Figure 3.0). Structures like fencing and walls were developed in order to protect farms on the ground from mass wasting events such as flooding and flash floods.

![Image of landforms](image)

*Figure 3.0: Students are able to build landforms such as river systems.*

Source: 6th Grade Students

Finally, students explored how human impacts upon the earth can affect urbanization and water quality. Students were able to explore the processes that engineers use for their careers. Students were enveloped into a design process that tasked them to ask, imagine, build, evaluate and share design processes.

After designing processes to plant, water and sustain crops, students explored how to harvest, clean and transport crops in the virtual world. Students were able to explore why clean water is necessary for farming operations and what potential limits like cost, time or materials could impact their design. They imagined ways farmers cleaned their crops and how they might have developed clean water resources.

Students needed to design and build a water filtration system that cleaned the water used to rinse crops. Students had to keep limiting factors like time, materials and contamination in
mind as they built their systems. All water systems for cleaning crops had to be safe for human use. Students also were tasked with developing a transportation system that moved crops from the water filter to the barn (base of operations for packing crops) (See Figure 4.0).

*Figure 4.0: Students develop irrigation and transportation systems in the MinecraftEdu game*

Source: 6th Grade Students
As students were able to build their models in the virtual world, they used drawings in order to plan and develop diagrams of their idea(s) (See Figure 5.0). Students developed an active list of materials needed for their designs to come to fruition in the virtual world. As the students consulted their original diagrams vs. the actual model in the virtual world, students could identify what differences occurred between their drawings and the virtual model.

*Figure 5.0: Student drawn plans for virtual model design. Students could identify what differences occurred between their drawings and the virtual model.*

Source: 6th Grade Students
Students were motivated to explore how switches, pressure plates and Redstone could be used in order to make their designs automated in order to preserve time, costs and labor (See Figure 6.0).

![Image](image1.png)  ![Image](image2.png)

*Figure 6.0: Students explored how switches, pressure plates and Redstone could be used to compliment their designs in the virtual world.*

Source: 6th Grade Students

Students tested their models in the virtual world, recorded the results and reflected if the model did what was expected. They were also able to reflect upon the materials used in the design and if the materials worked or what others might be better. As students actively explored the virtual environment, different limiting factors that could contaminate their water systems or derail their transportation systems were applied in the game. Students had to problem solve, revise and design ways to make their creations sustainable to contamination, weather and monsters (used in place of animals).
Data Collection

A business method used to understand gamification objectives is called the MDE Framework (See Figure 7.0). It categorizes successful gamification concepts into three criteria. The criteria are mechanics like game rules and progression, dynamics like player behavior and emotional responses and emotion like the player’s state of mine. In order to align student-learning behaviors with gamification mechanics, I adapted the MDE framework to meet the needs of my students and their project. I wanted to observe how student understanding of game mechanics influenced or changed student learning behaviors.

![Figure 7.0: The MDE Framework Describing the Principles of Gamification](Gamified Experience)

Source: Robson (n.d.)

I first identified game mechanics that would be necessary for my students to understand in the MinecraftEdu game. I adapted a Rubric for students to self-assess their emotional responses while playing the MinecraftEdu game. I categorized understanding of game mechanics from basic to advanced. A score of Novice represents basic understanding of game mechanics and a score of Expert represents advanced understanding of game mechanics. As students
explored the virtual learning space, their understanding of game mechanics were self-assessed with the Rubric below:

<table>
<thead>
<tr>
<th>Novice (1)</th>
<th>Students seek to understand the game and are motivated to learn how the Minecraft game works before play.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apprentice (2)</td>
<td>Students are comfortable with basic gameplay controls and students are knowledgeable about the Minecraft game. Since students are comfortable with the game, it is easier for the student to accomplish their task.</td>
</tr>
<tr>
<td>Practitioner (3)</td>
<td>Students expect a challenge in the virtual world. Students enjoy learning more about the Minecraft game like blocks, levers and plates. The more the student knows about the Minecraft game, the easier it is for them to accomplish tasks.</td>
</tr>
<tr>
<td>Expert (4)</td>
<td>The student feels confident in their abilities to control and manipulate the game. The student is able to do anything within the rules and/or constraints of the game.</td>
</tr>
</tbody>
</table>
Next, I identified specific Student Habits of Mind that I wanted to improve during the project. Students completed a second self-assessment in order to identify their state of learning behaviors like perseverance, taking educated risks and imaginative thinking. I adapted another Rubric to be used for self-assessment of each learning behavior while playing the Minecraft game (See Figure 8.0). I categorized states of learning behaviors from basic to advanced in order to identify any commonalities with the scores of the game mechanic rubrics. A score of Novice represents basic demonstration of learning behaviors and a score of Expert represents advanced learning behaviors. As students explored the virtual learning space, their learning behaviors were self-assessed with the Rubric below:

![Figure 8.0: Student Habit of Mind Learning Behavior Rubric](image)

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Novice</th>
<th>Apprentice</th>
<th>Practitioner</th>
<th>Expert</th>
</tr>
</thead>
<tbody>
<tr>
<td>I can stay on task no matter how difficult it is to find answers to solutions</td>
<td>In a very limited way</td>
<td>In a limited way</td>
<td>Yes, with minimal difficulty</td>
<td>Yes, with ease and minimal hesitation</td>
</tr>
<tr>
<td>I can use a variety of strategies and resources to solve a problem</td>
<td>In a very limited way</td>
<td>In a limited way</td>
<td>Yes, with minimal difficulty</td>
<td>Yes, with ease and minimal hesitation</td>
</tr>
<tr>
<td>I always stay on task when trying to find answers or solutions to problems</td>
<td>Not really. Answers are difficult to find.</td>
<td>Most of the time, answers are still difficult to find.</td>
<td>Yes, with minimal difficulty</td>
<td>Yes, with ease and minimal hesitation</td>
</tr>
<tr>
<td>I try to complete tasks when the answers or solutions are not readily available, but I give up when the task is too difficult</td>
<td>Rarely. It is difficult for me to complete a task.</td>
<td>Some of the time. It is difficult for me to complete a task.</td>
<td>Most of the time. I do my best to find answers to problems but sometimes I give up.</td>
<td>Always, however I do not give up on completing tasks easily.</td>
</tr>
<tr>
<td>I get off task easily.</td>
<td>All the time. I do not like the activities in Minecraft Edu and I do not like learning in a virtual world.</td>
<td>Some of the time. I don't know if I like the activities in Minecraft Edu. Virtual worlds are sometimes confusing.</td>
<td>Very rarely. I like the activities in Minecraft Edu and I like learning in a virtual world.</td>
<td>Almost never. I find myself engaged in the activity and I LOVE using Minecraft Edu to learn.</td>
</tr>
<tr>
<td>I give up easily and quickly on difficult tasks. I am unaware of available resources to help me find the answer to solutions.</td>
<td>Often.</td>
<td>Sometimes.</td>
<td>Rarely.</td>
<td>Almost never.</td>
</tr>
</tbody>
</table>
Understanding grade-specific content aligned with the Florida State Standards, students completed a project packet in small groups. They were able to ask, imagine, build, evaluate and share their scientific models. By developing solutions to environmental sustainability, irrigation and water quality, students were able to plan and build models in the MinecraftEdu game.

**Data Analysis**

By using elements adapted from the MDE Framework, I evaluated Rubrics to determine the relationship between game mechanics and learning behaviors. Based upon data from student self-assessment Rubrics, I am able to infer that a theory of change occurred as students developed a more complex understanding of the Minecraft game. As students demonstrated proficient understanding of game mechanics, their perceived learning behaviors during the project were advanced as well. Students used strategic behaviors and readily available resources in the game to make their farms sustainable. I am able to infer that there is a direct relationship between learning behaviors and understanding of game rules and actions. Scores of practitioner and/or expert were obtained on Rubrics measuring Student Habits of Mind. Subsequently, scores of practitioner and/or expert were obtained on Rubrics measuring Student Understanding of Game Mechanics.

As students took educated risks in the virtual space, one student said, “I took an educated risk on my water filter because of my resources. I didn’t like some of the materials that I used.” By expecting a challenge in the MinecraftEdu game and learning about the blocks and their qualities, this student was able to collaborate with their peers, test their model with new materials and evaluate if the materials they used worked. Higher order thinking resulted as students imagined what changes they might make to improve their models, why they would make the change and evaluate if the model did what was expected. This process occurred in the physical
classroom and virtual space. The MinecraftEdu game allowed students to be makers, tinkerers and explorers as they imagined, built and evaluated their designs.

Findings & Conclusions

In conclusion, based upon a student survey, nearly (96%) of students enjoyed using MinecraftEdu as a learning activity and (92%) of students preferred to work in social groups. The use of blended learning formats during instruction developed an inherent social learning community and new instructional best practices as a result of the inquiry process. Excitingly, student understanding of scientific content was demonstrated through student design process packets and virtual models. The use of MinecraftEdu as a learning tool for project based learning enabled students to demonstrate their passion for learning and use their imaginations in order to improve designs and develop solutions for farming and sustainability. Students remained engaged and developed leadership qualities by helping peers, collaborating and communicating. It was not the final product that was most important in the virtual space, but rather the learning processes and experiences that enabled students to problem-solve and understand the world around them. By aligning gamification objectives with student learning behaviors, games can be leveraged for learning in order to achieve something beyond traditional supportive learning communities.

Recommendations

The uses of virtual worlds like MinecraftEdu are tremendously popular in the educational process. Although previous studies have mentioned a broad range of gamification designs that might influence learner engagement, most ‘gamified’ instruction fails to meet learning objectives because of a lack of research regarding suitable game design, as well as poor rationale for or design of gamification mechanics (Chang & Wei, 2015, p.177). Further study of learner digital engagement, which refers to the learning and everyday engagement of learners with available technologies in their learning ecologies, including both daily life and school contexts can influence the ways educators compliment their instruction with gamification principles.
Numerous elements of gamification are based on educational psychology and techniques that instructors have been using for years. During the backwards design process of project based learning, further research can inform decision makers about the processes to decompose the overarching goal into its constituent parts, progressing, from the general to the specific perspective. More manageable learning segments ordered into an appropriate hierarchy of detail could determine the most influential gamification mechanics of virtual learning worlds and their relative advantage to influencing student behavior during technology-supported project based learning units. These results can optimistically assist educators in designing learning units and identify engaging gamification mechanics to enhance learner’s engagement (Chang & Wei, 2015, p.178-179).
Reference


