Get in the Game: Using Minecraft: Education Edition to Increase Student Interest in Engineering and Technology

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Capstone Project Proposal

Setting and Context

The setting for my capstone project is McClure Middle School (MMS) located in Kennesaw, Georgia. Kennesaw is a suburb of the northwest Atlanta metropolitan area. MMS serves students in sixth through eighth grades. MMS takes pride in focusing on the social and emotional needs of our students to help drive success. It is a "school choice" school, and 10.05% of the student body are students who choose to attend MMS over the school in their district. However, enrollment has dropped slightly over the past few years, and the student population currently stands at 1035. The 2020 demographics of MMS are as follows: Caucasian (59.8%), African American (16.3%), Hispanic (14.3%), Multiracial (5%), Asian (4.3%), and Other (0.2%). McClure's economically disadvantaged students represent 24% of our population, which is significantly higher than the 8% listed on its 2019 report card and could be attributed to the effects of the pandemic (Governor's Office of Student Achievement, n.d.).

Established in 2006, MMS has formed a great reputation within its community. MMS's "overall performance is higher than 87% of schools in the state, its students' academic growth is higher than 77% of schools in the state, [and] 87.4% of its 8th grade students are reading at or above the grade level target" (Governor's Office of Student Achievement, n.d.). The principal, Mr. Cory Stanley, is in his first year at MMS. Currently, MMS is also served by two assistant principals, as well as a Special Student Services Administrator. Two positive major initiatives at MMS include a continuation of PBIS (Positive Behavior and Supports), as well as currently establishing an SEL (Social and Emotional Learning) learning initiative. MMS's PBIS program began 2 years ago and focuses on teaching and rewarding positive behaviors. SEL is a county-

wide focus this year and like PBIS, helps promote positive behavior and personal responsibility. Another critical tenet of SEL is that it focuses on developing self and social awareness.

My project will take place in my personal classroom with my sixth-grade engineering and technology students. My curriculum standards are STEM-focused and very interdisciplinary at their core. My computer lab has 33 computer workstations, as well as a 3D printer. The goal of my project is to help increase the engagement of my students, as well as increase their content knowledge and interest in technology and engineering careers. PBIS and SEL will also be intertwined into my study through game-based learning, inclusion, and social skill development. Collaboration, critical thinking, and problem-solving activities will be the foundation of my project. I feel by captivating my students' interest and bolstering their engagement at this grade level will help establish a foundation to build both their engineering and technology knowledge, as well as reinforce other subjects' content knowledge through STEM's inherent interdisciplinary connections.

Statement of Problem, Need, and Rationale

Problem Statement

My capstone project will be conducted in my classroom with my sixth grade pre-Engineering and Technology (STEM) students. The need that prompted this project proposal is that there is a recurring STEM skills gap that I have observed in my students regarding critical STEM skills such as collaboration, critical thinking, problem-solving, and connecting academic knowledge and standards to the real world. This could be caused by many factors, but it is my belief that a major problem is a lack of STEM educational opportunities available for many students at the primary education level.

STEM education is meta-disciplinary approach and should always aim to combine disciplines in a way that is authentic and meaningful. Also, collaboration, critical thinking, and problem-solving are very impactful 21st century skills that have been identified (Hewett, Zeng, and Pletcher, 2020), so learning these skills will help young people well beyond the walls of a STEM classroom. Incorporating a more engaging approach to teach STEM skills, such as game-based learning, will hopefully create more interest in my curriculum, eventually bridging critical STEM skills gaps.

Connection to Research

According to Jones et. al (2018), "To meet the growing global demand for a STEM workforce, every segment of the U.S. population will need to be engaged in a successful STEM education" (p. 2). Although I completely agree with the above statement, STEM still suffers from a lack of awareness and integration in my experience. Even in my school district, which is a high achieving district compared to many, STEM is loosely governed. Yet many influential technological leaders, such as Bill Gates and Steve Jobs, have worked hard to spread its ideology. President Obama and his administration went to "unprecedented levels of public-private collaboration in STEM education" (Handelsman & Smith, 2016, Introductory Paragraph). These effects have been felt, but I fear that without a continued focus on STEM and an appreciation of STEM, progress could be lost. STEM related skills and a STEM workforce are major needs in the future for the US, and many jobs in this field are not being filled.

Proposed Solution/Intervention

The rationale for my project is that by using game-based learning and collaborative project-based learning strategies, my students will be more engaged and will learn how to apply content standards in a more intuitive way. By leveraging Minecraft: Education Edition (M:EE),

students will be presented with a more authentic learning experience. Many students have played Minecraft before and have a familiarity and comfortability with it. Many of those same students excel in a game/digital environment, where they can show off some of these same skills. By building projects digitally, students will be using the engineering design process more completely, as opposed to an inquiry based or a strictly conceptual approach to learning. Although I do hands-on activities in my curriculum, the use of M:EE and game-based learning will allow me to create and apply more standards without having to purchase consumables. Multimodal representations of content knowledge have a more lasting effect on the different learning styles seen in my classroom. M:EE has an impressive collection of lessons prepared by teachers throughout the world and across all disciplines. Also, by implementing M:EE consistently, a familiarity with the program and procedures will be established. The fact that M:EE is a sandbox game will also allow me to create my own "worlds" with their own learning outcomes, gameplay, and assets when I get more comfortable using and implementing lessons.

Another reason for this project is that I am a full inclusion classroom. My classroom hosts many Mild Intellectual Disability (MID) and Emotional/Behavior Disorder (EBD) students along with a range of general education students and Special Education students. While all classes in MMS demographics vary, the Connections classes include the most diversity. Developing a STEM curriculum that appeals and is best suited to a diverse population has its challenges. My rationale is that by using game-based learning, specifically M:EE, the playing field will be one that most students find engaging, but more importantly, one in which most students will successfully learn my content standards.

Connection to Research

Research indicates that incorporating Minecraft into your curriculum can create a more inclusive environment (O'Sullivan et. al, 2017; Ringland et. al, 2016). Addressing a more diverse population at a younger age will hopefully translate into an understanding and appreciation for STEM that will continue to develop at a post-secondary level of education. Regarding engagement, Toscano, Lugo, and Watson (2015) state, "For teachers, increasing the level of student engagement is, in itself, beneficial and may lead to better learning outcomes" (p. 10). Minecraft is an excellent resource to be used as an education tool. Nebel, Schneider, and Rey (2016) echo this by saying "blocks can be arranged in a way that could reproduce almost every static object or shape, thus providing stimuli for a very different set of education or research projects." (p. 5). The ability for you to create your own worlds, combined with the fact that many worlds have been created already by an active community, and are accessible through minecraft.education.net, make Minecraft Education an extremely appealing medium. Put another way, Minecraft's "open-ended nature and collaborative approaches foster student communication and context-based language use" (Kuhn, 2018, Conclusion). Minecraft's versatility and constructivist nature also supports my rationale for this capstone project. I have a great opportunity to use technology to help reinforce STEM skills and content knowledge in a way that is engaging and authentic for my students.

Project Objectives

The overall goal of my project is to increase engagement in my students by aligning game-based learning with engineering and technology standards in a more engaging and inclusive way. The objectives of this project are aligned with the overall goal of increasing engagement:

1. I will survey my students at the beginning and end of the semester to show growth through a self-assessment/reflection of their engagement.

2. Approximately 5 students will be chosen who struggle with engagement in my classroom. Their progress will be followed throughout the semester, and an increase in their class grade will be proven by their increased engagement.

PSC Standards

- **2.1 Content Standards & Student Technology Standards:** Candidates model and facilitate the design and implementation of technology-enhanced learning experiences aligned with student content standards and student technology standards. (PSC 2.1/ISTE 2a)
- **2.2 Research-Based Learner-Centered Strategies:** Candidates model and facilitate the use of research-based, learner-centered strategies addressing the diversity of all students. (PSC 2.2/ISTE 2b)
- **2.3 Authentic Learning:** Candidates model and facilitate the use of digital tools and resources to engage students in authentic learning experiences. (PSC 2.3/ISTE 2c)
- **2.4 Higher Order Thinking Skills:** Candidates model and facilitate the effective use of digital tools and resources to support and enhance higher order thinking skills (e.g., analyze, evaluate, and create); processes (e.g., problem-solving, decision-making); and mental habits of mind (e.g., critical thinking, creative thinking, metacognition, self-regulation, and reflection). (PSC 2.4/ISTE 2d)
- **2.5 Differentiation:** Candidates model and facilitate the design and implementation of technology-enhanced learning experiences making appropriate use of differentiation, including adjusting content, process, product, and learning environment based upon an analysis of learner characteristics, including readiness levels, interests, and personal goals. (PSC 2.5/ISTE 2e)

- **3.1 Classroom Management & Collaborative Learning**: Candidates model and facilitate effective classroom management and collaborative learning strategies to maximize teacher and student use of digital tools and resources. (PSC 3.1/ISTE 3a)
- **3.2 Managing Digital Tools and Resources:** Candidates effectively manage digital tools and resources within the context of student learning experiences. (PSC 3.2/ISTE 3b)
- **4.3 Diversity, Cultural Understanding & Global Awareness:** Candidates model and facilitate the use of digital tools and resources to support diverse student needs, enhance cultural understanding, and increase global awareness. (PSC 4.3/ISTE 5c)
- **Professional Learning:** Candidates develop and implement technology-based professional learning that aligns to state and national professional learning standards, integrates technology to support face-to-face and online components, models principles of adult learning, and promotes best practices in teaching, learning, and assessment. (PSC 5.2/ISTE 4b)

Project Description

For my Capstone project, I will be integrating game-based learning into my curriculum due to my belief that there is a correlation between game-based learning, student engagement, and inclusion. Specifically, I will focus on implementing Minecraft Education lessons more strategically into my curriculum, with a focus on critical STEM skills such as collaboration, problem-solving, higher order thinking, critical thinking skills, as well as aligning the game-based lessons with my GA Engineering and Technology (STEM) standards. By leveraging Minecraft, my objective is to increase engagement and interest in Engineering and Technology by facilitating learning in a more meaningful way. Table 1 outlines the project items/activities, objectives, and deliverables that will comprise my capstone project.

Table 1

Project Item/Activity	Project Objective(s)	Deliverable(s)
Administer a survey at the beginning of the semester.	Self-Assessment/Reflection	A pre-assessment survey
Students work in groups to build a 2D pixel representation of a design that exists in the real world.	Formative Assessment	Computers; Minecraft World; Lesson Plan; Post-Reflection
Students work to solve codes to break out of 4 separate levels in Minecraft to advance to the next level.	Formative Assessment	Computers; Minecraft World; Lesson Plan; Post-Reflection
Students will learn more about the scientific method by exploring *Science Island* in Minecraft EDU.	Formative Assessment	Computers; Minecraft World; Lesson Plan; Post-Reflection
Students will learn about Rube Goldberg machines using a Minecraft EDU lesson.	Formative Assessment	Computers; Minecraft World; Lesson Plan; Post-Reflection
Students will explore the real-world problem of deforestation in Minecraft EDU.	Formative Assessment	Computers; Minecraft World; Lesson Plan; Post-Reflection
Students will explore the concept of base ten by completing base ten puzzles in Minecraft EDU.	Formative Assessment	Computers; Minecraft World; Lesson Plan; Post-Reflection
Students will explore spatial reasoning by exploring *Volume World* in Minecraft EDU.	Formative Assessment	Computers; Minecraft World; Lesson Plan; Post-Reflection
Students will create a virtual community in Minecraft EDU.	Formative Assessment	Computers; Minecraft World; Lesson Plan; Post-Reflection
Administer a survey at the end of the semester.	Self-Assessment/Reflection	A post-assessment survey

Evaluation Plan

For this capstone project to be successful, I need to successfully integrate M:EE into my units to increase student engagement in a measurable way.

For my first objective, I will survey all my students with a pre and post survey mixing Likert style questions with open-ended questions which ask the students specific questions regarding my class and the units they have worked on over the semester. The goal of the surveys is to show growth in student engagement from the beginning to the end of the semester. The first survey will give me a good baseline to build on, as well as help identify students to use for my second objective. The second survey, given at the end of the semester, will show the growth in student engagement through Likert style ratings, as well as questions where students can express their personal feelings regarding the units, specifically how using Minecraft did or did not affect their interest in the subject matter.

For my second objective, I will formatively assess 5 students during the semester on the activities listed in Table 1 and show growth in their grades paired with the results of their post survey/reflection.

Table 2.
Project Timeline

Month/Year	**Project Item/Activity, or Evaluation Item**	**Hours**
December 2020	Research survey questions for assessing engagement in students to use for my pre and post surveys for my capstone project.	10 hours
January 2021	Meet with my mentor to review and fine tune questions for my survey.	5 hours
January 2021	Administer pre survey to my sixth-grade engineering and technology students.	2 hours
January-May 2021	Explore lesson plans and Minecraft worlds to prepare for teaching them in my classroom, as well as to make any adjustments necessary. Research other Minecraft lessons for the future.	25 hours
January 2021	Implement the breakout Minecraft activity to get the students accustomed to the gameplay and expectations in class.	2 hours

January 2021	Implement the *Science Island* Minecraft activity to practice using the scientific method.	2 hours
January 2021	Implement lesson on the Engineering Design Process (EDP) to teach the students the steps of the EDP, and to compare and contrast the EDP to the Scientific Method.	2 hours
February 2021	Implement the 2D Pixel lesson in Minecraft to reinforce 2D representation.	2 hours
February 2021	Implement the *Volume World* lesson in Minecraft to reinforce 3D space.	2 hours
February 2021	Implement the deforestation lesson to reinforce and apply real world problems and how to utilize the EDP.	2 hours
March 2021	Implement the Rube Goldberg machine Minecraft lesson.	2 hours
April 2021	Implement the virtual community lesson in Minecraft.	2 hours
April-May 2021	Implement the *Coding Fundamentals Block 1* lessons in Minecraft to learn basic programming concepts	7 hours
May 2021	Administer pre survey to my sixth-grade engineering and technology students.	2 hours
January-May 2021	Conducting formative assessments for my 5 students.	5 hours
August 2021	Administer pre survey to my sixth-grade engineering and technology students.	2 hours
August 2021	Implement the breakout Minecraft activity to get the students accustomed to the gameplay and expectations in class.	2 hours
August 2021	Implement the *Science Island* Minecraft activity to practice using the scientific method.	2 hours
August 2021	Implement lesson on the Engineering Design Process (EDP) to teach the students the steps of the EDP, and to compare and contrast the EDP to the Scientific Method.	2 hours
September 2021	Implement the 2D Pixel lesson in Minecraft to reinforce 2D representation.	2 hours
September 2021	Implement the *Volume World* lesson in Minecraft to reinforce 3D space.	2 hours
October 2021	Implement the deforestation lesson to reinforce and apply real world problems and how to utilize the EDP.	2 hours
October 2021	Implement the Rube Goldberg machine Minecraft lesson.	2 hours
November 2021	Implement the virtual community lesson in Minecraft.	2 hours

November 2021	Implement the *Coding Fundamentals Block 1* lessons in Minecraft to learn basic programming concepts	7 hours
August-December 2021	Conducting formative assessments for my 5 students.	5 hours
December 2021	Administer pre survey to my sixth-grade engineering and technology students.	2 hours
	Total Hours:	102

Resources Needed

The resources needed to successfully complete my capstone project are listed below.

Lesson Resources

- Lesson Plans
- Facilitation Guides if Needed
- Student Notebook
- OneNote Class Notebook

Technology

- Minecraft Education Software
- Minecraft World Download (file)
- Computer
- Interactive Flat Panel
- Presentation Software
- Headphones

Physical Space

- Computer Lab (My Classroom)

Human Resources

- Sixth-grade Engineering and Technology Students

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