Pre-Service Teachers Learn to Teach with Serious Games

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Abstract

The goal of this study was to determine whether a game-based immersion experience in an introductory undergraduate course in education had an impact on students’ perceptions of their skills, attitudes, and confidence using games for teaching academic content. Fifty-five students with an interest in education participated in the study. They developed game-based lesson plans, assessments, and videos on topics of their choice in Minecraft. We used a mixed methods design using quantitative (pre-post test comparisons) and qualitative data (reflection essays) to examine the impact of the curriculum on students’ preparation to design technology-based lessons for use in middle and secondary school classrooms. Most students chose to create lessons in STEM topics regardless of their declared major. At the start of the course, the students were very skeptical of using game-based technologies in the classroom. Pre-post tests and reflection essays provide strong support for changes in confidence, skills, and attitudes during the semester.

Keywords: STEM, Minecraft, pre-service, education, serious games, game-based learning

Technologies are rapidly changing and so are standards for how we as educators need to respond. Students who begin college this year will find the landscape of technology has changed by the time they complete their college degree and enter the classroom as teachers. In 2015, President Obama initiated the ConnectHome project to bring all Americans into this rapidly changing environment and have access to digital opportunities (White House, 2015). The US Department of Education in 2016 published their Future Ready Learning Report with goals for technology infrastructure that ensure that all teachers and students: be connected to high-speed internet in and out of school, have access to mobile devices to connect students and teachers for collaboration, and have high quality digital learning content (U.S. Department of Education Office of Educational Technology, 2016a, p. 65).

Connecting students and teachers to technologies is not enough. In 2015, the Council for Accreditation of Teacher Preparation (CAEP) issued standards that require new candidates for teaching to model and apply technology in their engagement with students (CAEP, 2015). Additionally, the International Society for Technology in Education (ISTE) released new standards for teachers in 2018. These new standards emphasize the need for teachers to scaffold student learning with technologies, and in turn, the need for teacher education programs to prepare future teachers to create student-centered learning with technology.

Preparing teachers to meet these standards is not just about training them to use Google classrooms or new apps, like Kahoot! The challenge goes beyond merely adapting to change. A frontier in educational technology that is emerging in public consciousness, called “serious gaming,” challenges teachers to connect their instruction to the everyday games students use in their lives (Takeuchi, 2014). From the perspective of “serious gaming,” the real challenge is how to take a technology that students currently use for their own enjoyment, and link it to meaningful academic content and objectives, without losing the appeal of the technology.

In this study, we describe the design and evaluation of a project in an introductory education class for students with an interest in teaching. The project was designed to prepare students to use Minecraft as a part of their lesson planning in a wide array of content areas. Over three semesters, Fall 2015, Spring 2016, and Fall 2016, 55 students in Siena College’s Education 210 Course, Issues in Contemporary American Education, participated in the same sequence of experiences designed to help them use Minecraft for teaching academic content. Students completed a pre-post test survey assessing their skill using technology, and their confidence in using technology to create lessons for middle- or high-school-aged students. In Fall 2016, 43 students wrote a reflection essay on their experiences with technology in the course. This assignment was added to the course in Fall 2016 to provide a free-response writing assignment to describe the impact of the project in their own words.

Serious Games

In the world of education, the terms “serious games” and “game-based learning” are used synonymously. Serious games or game-based learning must have both entertainment and pedagogical value. Zyda (2005), provided a definition, “Serious game: a mental contest, played with a computer in accordance with specific rules, that uses entertainment to further government or corporate training, education, health, public policy, and strategic communication objectives” (p. 25). Serious games include games developed to be educational tools and those that were developed primarily as entertainment, but have been adapted or redesigned for educational purposes.

Use of games to teach academic content is a promising avenue of technology use to promote motivation and engagement. Educational versions of popular programs are cropping up with games such as MinecraftEDU, KerbalEDU, CivilizationEDU, and games developed for STEAM for schools (Lorence, 2015; Donnell, 2013). The number of conferences specifically about games in education is growing to support teachers and spread ideas about gaming and how it can apply to traditional subjects (Games in Education Conference, 2017).

Minecraft is a versatile game for teachers to use in an educational way. Though it was created purely for entertainment purposes, it is already in use all over the world as an educational tool in a vast array of content areas. It has open access to its code, allowing users to make modifications (also called Mods), and there are a multitude of these available for those with less skill. There are thousands of YouTube videos and helpful websites that provide answers to do anything imaginable in Minecraft. It has also been used for research in a number of areas because of its versatility and ease of modification (Nebel, 2016). With Microsoft’s purchase of Minecraft in 2014, they’ve invested in the creation of Minecraft Education Edition for use in schools.

Romero and Barma (2015) report that the pre-service teachers in their study identified challenges in using an existing game, repurposing an existing game, and creating a new game as a barrier. Li, et. al. (2012) and Akcaoglu and Kale (2014) report that immersion impacted their pre-service teachers’ perceptions related to challenges, problems solving, and attitudes toward gaming and design.
Background on the Minecraft Project

In Fall of 2015, an introductory course in teacher education was redesigned to prepare pre-service students to use new technologies in planning lessons for use in schools. The course was organized to provide exposure and training in a new technology. Students were also taught how to write lesson plans and assessments. Minecraft was selected as the gaming environment because of its versatility, popularity and familiarity among school-aged students. The gaming environment is designed as a "sandbox," meaning it is a space in which a player can collect material and build with it. Unlike a sandbox, the game provides access to many different virtual materials, which become building blocks for use in the game. These raw materials can be used to create new materials within the game.

The Minecraft project lasted 7-weeks. There were 14 classes of 1 hour and 25 minutes, or approximately 21 hours of in-class time devoted to the project. During the first class, students practiced playing Minecraft in a tutorial world. Next, they experienced two example lessons in physics. These were taught by physics students, who had led the lessons with middle and high school students. The remaining classes allowed students to develop their Minecraft environment, create their online assessments in Google Forms, write detailed lesson plans shared in Google Docs, and create movies to orient players to the classroom environment, though in somewhat different ways.

Data Sources and Analysis

Methods

Sample

Fifty-five students completed the pre-post test survey for inclusion in the study. They were from 18 different declared majors, and 4 undeclared areas of interest. Sixty-seven percent (n=37) were female. Most were freshmen (38%, n = 21) or sophomores (35%, n = 19). Twenty percent (n = 11) were juniors and 7% (n = 4) were seniors. Forty-four percent (n = 24) were in an education related major or major leading to education certification (Chemistry Education, History or History Education, Arts Education, etc.). Ten percent (n = 5) were in a STEM-focused major (1 each in Chemistry, Biology, and Physics, and 2 in Computer Science).

Written reflections.

At the conclusion of the Minecraft project, 43 students (2 sections in Fall 2016) completed a written reflection designed to allow students to describe their experience with new technologies and its impact in their own words, writing an average of 791 words (SD = 95). The following was given as a guide:

Describe your experience with technology in Educ 210 and highlight any changes you noticed about: how the classroom environment changed over time, how you changed. What were you like in the beginning and how did you change overtime. What did you think about the use of Minecraft technology for teaching? Did that change? Did you learn or discover anything on your own (about your topic, about Minecraft, about teaching)?

Finally, summarize your overall impression – what did you learn about the use of technology like Minecraft for teaching (pros, cons, challenges, possibilities, etc.)? Your response should be at least 750 words.

An inductive thematic analysis was conducted with a focus at the explicit / semantic levels of the essays (Braun & Clarke, 2006). This allowed for an analysis of student perceptions of Minecraft that were not attained through student surveys.

After becoming initially familiar with the data, the primary author grouped segments of the essays, based on commonality across comments from students. These formed the initial codes whose collation led to three broad themes: 1) Positive Change in the Classroom Environment as a result of using Minecraft, 2) Positive Change in Student Beliefs about using Minecraft as a Form of Teaching, and 3) Barriers to Adoption of using Minecraft as a Method of Teaching.

Initial codes were identified as themes, if 100% of students made a related comment. Every student made a comment reflecting how the use of Minecraft led to a positive classroom environment, though in somewhat different ways. For example, they discussed how engaged they felt using Minecraft in class as compared to a typical classroom, while others compared their group work as more positive than typical group-based projects. Each of these examples represents how the experience positively impacted them personally as a student in the classroom.

Secondary processing of coding within these broad categories led to sub-themes. A set of codes was identified as a sub-theme, if 15% or more of students mentioned or identified the idea. Results are presented in Table 2 and organized by theme. Examples from students’ comments are provided for each sub-theme. The relative length of these sections roughly reflects the strength of emphasis in the collection of essays. Positive change in their acquisition of skills/knowledge is the longest, and it was mentioned most often in the essays.

Results

We report the results in three sections. The first compares the pre-post test scores using the technology survey. The second section summarizes the frequency of sub-themes from the reflections using percentages of students who mentioned the idea. Finally, the third section summarizes the major themes and ideas in the reflection essays and provides examples through student quotes to illustrate each theme / sub-theme.
The effect of the curriculum on time spent gaming was nonsignificant, but marginal, \( F(1,53) = 3.03, p < .057 \), \( \eta^2 = .067 \). Women reported receiving guidance from the instructor to one of collaborating, no one knowing each other and only communicating and no interaction of gender with pre-post test effect in any of the analyses (\( p > .15 \)).

**Gender**

Between subjects effect of gender was nonsignificant for confidence with new technology, \( F(1,53) = .003, \eta^2 = .01, p = .91 \), perception of skill using new technologies, \( F(1,53) = .003, \eta^2 = .91, p = .96 \), and general attitudes toward new technology, \( F(1,53) = .003, \eta^2 = .006, p = .94 \). The effect was significant for time spent gaming, \( F(1,53) = 27.82, p < .001, \eta^2 = .34 \). The effect of the curriculum on time spent gaming was nonsignificant, but marginal, \( F(1,53) = 3.03, p = .09, \eta^2 = .05 \). The effect on time spent with social media was non significant, \( F(1,53) = .08, p = .78 \), and the effect on general attitudes toward new technologies was non significant, \( F(1,53) = 1.65, p = .21 \).

**Written Reflections**

Forty-three written reflections were collected from students in the Fall of 2016. Students were asked to write about any changes they experienced in the classroom while developing lessons in Minecraft and whether they experienced a change in their beliefs about using technology such as Minecraft for teaching. Three broad themes emerged in coding the responses.

1. **Positive change in the classroom as a student using Minecraft:**
   - I actually took a lot away from the example lessons, especially the physics one. That was really a turning point for me. Once I personally learned stuff from a Minecraft lesson, I understood the infinite possibilities of the game as a tool for education.
   - We had some sample lessons about physics, and I feel like by playing the Minecraft games, the material and lesson was much easier to understand. I had no interest in physics, but after the lessons and playing Minecraft my interest in physics went up.
   - When I was building my world, I learned a lot about my topic. I think it would be a really good idea to have kids make a world about a topic and then share their world with the class. This would build an interest to all kids, hopefully even the hard to reach student.
   - Through using this technology in the classroom I learned a lot about Minecraft, and teaching. I learned how to effectively use Minecraft in the classroom and how to play the game of Minecraft. I can now develop a lesson plan using this technology...I learned how to gain attention from students, the importance of teamwork in the classroom, and how to use technology effectively.
   - As we started playing, I picked up the basics quickly and easily. I liked that the professor just let us go around on our own. We were able to explore all the different opportunities Minecraft has to offer. By the end of this lesson, I was able to build a world to teach students about Newton’s three laws of motion.

2. **Engagement:**
   - I even saw myself change as a person in class. I am usually a quiet one who doesn’t like to talk or participate...I saw myself as more interactive and engaged in the material. I no longer hated going to class and was actually looking forward to it.
   - I experienced how being left to my own initiative motivated me to learn more and immerse myself more in the subject than if I was simply being lectured.
   - At some points I did not want to leave class because I was so engaged.
   - I noticed the classroom going from quiet and boring to fun and more communicative...it broke down this wall between the teacher and student. It was no longer the normal classroom, it was a classroom that was more engaged in the material being taught. Minecraft made the classroom more connected and way more fun.

**Sample Statements for Theme 1**

**Acquisition of knowledge / skills**

- I actually took a lot away from the example lessons, especially the physics one. That was really a turning point for me. Once I personally learned stuff from a Minecraft lesson, I understood the infinite possibilities of the game as a tool for education.
- “We had some sample lessons about physics, and I feel like by playing the Minecraft games, the material and lesson was much easier to understand. I had no interest in physics, but after the lessons and playing Minecraft my interest in physics went up.”
- “When I was building my world, I learned a lot about my topic. I think it would be a really good idea to have kids make a world about a topic and then share their world with the class. This would build an interest to all kids, hopefully even the hard to reach student.”
- “Through using this technology in the classroom I learned a lot about Minecraft, and teaching. I learned how to effectively use Minecraft in the classroom and how to play the game of Minecraft. I can now develop a lesson plan using this technology...I learned how to gain attention from students, the importance of teamwork in the classroom, and how to use technology effectively.”
- “As we started playing, I picked up the basics quickly and easily. I liked that the professor just let us go around on our own. We were able to explore all the different opportunities Minecraft has to offer. By the end of this lesson, I was able to build a world to teach students about Newton’s three laws of motion.”

**Engagement**

- “I even saw myself change as a person in class. I am usually a quiet one who doesn’t like to talk or participate...I saw myself as more interactive and engaged in the material. I no longer hated going to class and was actually looking forward to it.”
- “I experienced how being left to my own initiative motivated me to learn more and immerse myself more in the subject than if I was simply being lectured.”
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**Table 1: Means and Standard deviations of technology survey items by gender and time.**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Before Minecraft Project Pretest Mean (SD)</th>
<th>Before Minecraft Project Posttest Mean (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Male (n=18)</td>
<td>Female (n=37)</td>
</tr>
<tr>
<td></td>
<td>9.06 (2.78)</td>
<td>9.00 (3.38)</td>
</tr>
<tr>
<td></td>
<td>11.22 (3.02)</td>
<td>11.46 (2.85)</td>
</tr>
<tr>
<td>Confidence in using new technology for teaching (scale: 0 – 15)</td>
<td>1.94 (0.60)</td>
<td>1.92 (1.21)</td>
</tr>
<tr>
<td>Perception of skill with different types of technology</td>
<td>2.31 (1.10)</td>
<td>0.49 (0.73)</td>
</tr>
<tr>
<td>Time spent gaming</td>
<td>2.44 (0.86)</td>
<td>2.76 (0.68)</td>
</tr>
<tr>
<td>Time using social media</td>
<td>3.00 (1.03)</td>
<td>3.05 (0.85)</td>
</tr>
<tr>
<td>General attitude toward new technology</td>
<td>3.22 (0.73)</td>
<td>3.14 (0.86)</td>
</tr>
</tbody>
</table>

**Pre-Post Test Technology Survey**

Table 1 shows the means and the standard deviations for each of the survey questions and for the confidence with new technologies scale. Mean scores were higher at the posttest than the pretest for items on the survey and for the confidence scale. Repeated measure ANOVAs were significant for differences in perceptions of skill using technology, \( F(1,53) = 10.03, p = .003, \eta^2 = .16 \), and confidence with new technologies, \( F(1,53) = 27.82, p < .001, \eta^2 = .34 \). The effect of the curriculum on time spent gaming was nonsignificant, but marginal, \( F(1,53) = 3.03, p = .09, \eta^2 = .05 \). The effect on time spent with social media was non significant, \( F(1,53) = .08, p = .78 \), and the effect on general attitudes toward new technologies was non significant, \( F(1,53) = 1.65, p = .21 \).
Collaborative Interaction.

• “While using Minecraft the environment of the classroom drastically changed from the beginning towards the end. In the beginning, not many people knew how to use the game and most people were very frustrated. As a class, not many people knew each other and people were uncomfortable answering questions or talking to the people at their table…[T]he class became closer by using teamwork to get through different tasks. In the beginning of using Minecraft when the majority of the class did not know what to do, the people who knew what to do helped everyone else and taught us how to use Minecraft and made us feel more comfortable.”

• “In the beginning of the semester, no one really talked a lot in class and it was mostly the professor who talked while the students listened…Minecraft was fairly new, so the friendly and welcoming aspect of the environment came out. It made it easy to ask questions and work together to learn about technology and Minecraft itself. Eventually, when we started making our own lesson plans, the environment was more familiar and the groups worked with each other to get the task done.”

• “In the beginning of the lesson in Minecraft I would rush by obstacles and lesson pretty easily. I quickly learned that the whole point of these training missions was to help people who did not know Minecraft so I decided to help others out. And to be honest, I felt a lot better about myself. Helping out others who weren’t familiar with the game felt pretty good and also helped me make friends in the class.”

Positive change in beliefs about using Minecraft as a form of teaching.

When students wrote about the positive change in their beliefs about using Minecraft in a 5th -12th grade classroom, several types of ideas emerged:

• applicability of Minecraft as a method for teaching generally and teaching content specifically,
• engagement of students,
• collaborative interaction of students, and
• importance of learning technology skills.

Participants identified changes in their beliefs both about using technology, gaming, and Minecraft in particular, to teach educational content. Participants identified technology and Minecraft as an effective tool to teach many different content areas. They wrote that Minecraft would increase engagement in learning over traditional methods. Collaborative interaction was identified as important for students in schools to experience. They wrote that collaboration – working together to achieve a common goal, which came about naturally in their use of Minecraft in teams, would help students in schools learn teamwork, problem solving, and communication skills.

Providing students with opportunities to learn technology skills was identified as important.

Sample Statements for Theme 2

Applicability to many content areas

• “I was intrigued with the endless possibilities and the teamwork that went around the entire activity. Minecraft is a great way to teach…[S]omeone can teach about a topic that may not be typically accessible to everyday lessons, but is still able to allow students to get a firm grasp of the concept is truly remarkable.”

• “The game is a powerful tool and should be used by teachers. Minecraft can be used to teach almost any subject and is so simple to use. In our class, we saw almost every subject come to life in Minecraft, that was truly amazing to see! There was something in every MineCraft world that stood out to me…My skepticism from the beginning went away, and I became aware of how beneficial Minecraft can be for teaching. I learned a lot about different subjects, Minecraft, and education.”

• “It was interesting to see how different people took the lesson and made it their own. I really enjoyed the WWII lesson. I found it different than the others, since most everyone else’s were science- and math-based. The History lesson was really interesting to see and expanded my thoughts about what Minecraft could teach.”

• “My initial thoughts of Minecraft used for teaching were skeptical. The physics lesson about quantum mechanics in Minecraft was where my mind was changed. The fact the blocks moved when your character looked a different way was pretty impressive. If a lesson was taught using problems that could only be solved if you understood the content in Minecraft, I knew from then on a lot more could come from Minecraft lessons.”

• “Difficult concepts that can only be imagined in a normal classroom can be discovered in Minecraft. My own lesson, which taught slope, enabled students to visualize a negative slope in a more real way than if they simply had been taught in the two dimensional world of paper and blackboards. Because it enables students to enter a three dimensional world it enables teachers to teach three dimensional concepts.”

Engagement

• “With the use of this technology in the classroom it encourages the students to be more engaged in the lesson and provides them with a creative outlook. Students have a hard time paying attention to lectures so by using Minecraft it allows the students to work hands on and stay interested on the topic.”

• “I think Minecraft is a great way to teach kids. It will not only keep them engaged at the task at hand but very well make them want to go to school and learn.”

• “Minecraft engages students and teachers more, it provides a completely new and more effective way of learning, plus it merges learning with fun.”

• “Using technology, especially playing games, is mostly more entertaining and captivating than reading a lecture. Enjoying a lesson greatly increases the amount a student will learn from it.”

Collaborative Interaction for their future students

• “My favorite part of using Minecraft was being assigned to the group projects. By working altogether, I definitely felt more relaxed and free to work because I didn’t feel pressured… I realized from this exercise that allowing students to work in an environment where they feel free and safe to perform is the best way they can learn and retain new concepts/ideas/terms.”

Students need to learn to use technology to be successful

• “I can completely see the benefits…It allows for the students to keep up with the ever changing technological advances in society. Technology is everywhere in children’s lives…”

Barriers to adoption of using Minecraft as a method of teaching.

Students did not expand upon the barriers for adoption to the same degree that they expanded on the positive changes they experienced in the lesson. They mentioned five different barriers, listed below in order of most mentioned to least mentioned, including the steep learning curve, time, and complexity for teachers to learn the game and develop lessons, student distractibility, and the possible complexity for students to learn the game.

Sample Statements for Theme 3

Barriers for teachers

• “To begin with, I was extremely confused when trying to function in the game and would become frustrated when something was not working or I could not perform a certain task.”

• “The only challenges I see is the time needed to make the world… If a teacher is pressed for time and has no free time at home, this may be difficult.”

Barriers for students

• “It’s very easy for children to forget the purpose of an assignment. Children are also often distracted in the world, or they neglect looking at game instructions or tasks.”

• “It may be difficult to teach a lesson when students have no previous experience in Minecraft. The learning curve can distract from the real objectives of the lesson.”

Sub-theme Frequency Analysis

A summary of the coding of themes and sub-themes
is given in Figure 1. Abbreviations used in Figure 1 and the corresponding themes are listed in Table 2. Over 80% of students identified all of the 3 subcodes of positive change in their experience in the classroom using Minecraft to develop lessons with acquisition of skills mentioned by 95% of students. Fifty-six percent identified all of the 4 subcodes of positive change in their beliefs about using Minecraft as a method of teaching. Minecraft’s applicability for teaching and the opportunity for student engagement was identified by more than 93% of students. Forty-one percent of students identified all of the 5 subcodes of positive change in their beliefs about the development of lessons in a variety of content areas.

Table 2. Abbreviations of Sub-Themes.

<table>
<thead>
<tr>
<th>Theme</th>
<th>Abbreviation</th>
<th>Sub-themes</th>
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<tbody>
<tr>
<td>Positive change in environment</td>
<td>EACQ</td>
<td>Acquisition of skills</td>
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<td></td>
<td>EENG</td>
<td>Engagement</td>
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<tr>
<td></td>
<td>ECI</td>
<td>Collaborative interaction</td>
</tr>
<tr>
<td>Positive change in beliefs about teaching</td>
<td>TAPP</td>
<td>Applicability of Minecraft</td>
</tr>
<tr>
<td></td>
<td>TENG</td>
<td>Engagement</td>
</tr>
<tr>
<td></td>
<td>TCI</td>
<td>Collaborative interaction</td>
</tr>
<tr>
<td></td>
<td>TT</td>
<td>Importance of teaching technology</td>
</tr>
<tr>
<td>Barriers to adoption</td>
<td>BSD</td>
<td>Student distractibility</td>
</tr>
<tr>
<td></td>
<td>BLC</td>
<td>Learning curve for teachers</td>
</tr>
<tr>
<td></td>
<td>BT</td>
<td>Time to make lessons</td>
</tr>
<tr>
<td></td>
<td>BCT</td>
<td>Complexity of using Minecraft for the teacher</td>
</tr>
<tr>
<td></td>
<td>BCS</td>
<td>Complexity of using Minecraft for the student</td>
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</tbody>
</table>

Discussion

This study examined the experiences of college students participating in an introductory education course designed for future teachers to understand the role of new technologies in teaching. Using quantitative and qualitative research methods, the researchers sought to describe the impact of the course on students’ perceptions of their skills and confidence with technology. The present study revealed several unique findings that demonstrate how a brief experience in an introductory education course can impact students’ preparation to use new technologies for the development of lessons in a variety of content areas.

The extent of the change that students experienced from the beginning to the end of their course was not expected. Qualitative data indicate that nearly all students were strongly skeptical of using Minecraft for teaching at the beginning of the course. By the end, they were describing the benefits over barriers and advocating for the use of Minecraft in middle and high school classrooms. Pre-post comparisons showed moderate effects for changes in students’ perceptions of their skills and for their confidence in using technology to design instruction. We also found that young men reported higher levels of game use, and young women reported somewhat more social media use. Both groups were skeptical at the start and both reported their change similarly in their skills and confidence during the project.

Though all students reported some barriers to using
Minecraft, these comments represented a relatively small part of their overall reflections. Students wrote that they felt more confident with technology and learned academic content in the lesson they developed, and those developed by others. Though they were concerned about the time it might take for a teacher to learn Minecraft skills, they reported that their personal fears were somewhat unfounded. They accelerated more quickly to the technology, and to the task of creating a lesson, than they initially thought they would. They attributed this to their perception that Minecraft provided them freedom to explore, work on their own, and use their creativity. Many went on to reflect on the broad applicability of Minecraft. They were impressed with how their peers brought topics to life—topics they thought were inherently boring.

Model lessons in physics served as an introduction to Minecraft and allowed students in the course to see the possibilities because they were engaged in a difficult content area they weren’t expecting to like. Very few were interested in STEM, and many said they actively avoid STEM-based classes as much as possible. Still, they reported that they were surprised that they could actually enjoy learning about quantum mechanics and quarks. Interestingly, though there were few students in a STEM-related major, many of the lessons the students groups decided to create were in STEM content areas including math, physics, earth science, and biology. In another study we will be reporting on the impact of the curriculum on students’ attitudes toward science, and their knowledge gains on the two topics that were used to model the use of Minecraft for teaching (particle/atomic physics, and quantum mechanics).

The intervention included training, example lessons, freedom to choose their own lesson, much time to gain skills, immersion in a “gaming environment,” and the opportunity to work in a team. The class was held in a campus computer lab with Minecraft pre-installed. This study does not provide guidance on which factor or combination of factors contributed to perceived positive changes in student confidence or skill in using the technology for teaching. We suspect a combination of factors account for changes in the study reported here.

The question remains whether students in the course who go into teaching will actually design serious games for use in their future classrooms. We suspect that ongoing support and practice will be necessary. Elements from the course (modeling, scaffolding, practice, technology support) may serve as a guide for professional development of in-service teachers increasing confidence and immediate efforts to use new technologies, and specifically game-based learning in classrooms. These are topics for future investigation as we follow students through the certification program. At the very least, these pre-service teachers completed the course with positive experiences developing serious games and technology-based lesson plans.

Conclusions
Findings from this study suggest that a short-term intervention can impact student skill and confidence using Minecraft to design their lesson plans. We found changes in student confidence and skill with both quantitative and qualitative data sources. In addition to discussing the changes to themselves, they described changes to the learning environment and to whether teachers can meet the challenges posed by technology in education. Students also reported on the benefits of collaboration and teamwork. We found very few gender differences in the perceptions of the changes that students reported in their pre-post test surveys and Minecraft reflections.

References


Dr. Michele McColgan is an Asst. Professor of Physics and Astronomy at Siena College. She is the founder of Siena's Informal STEM Program and summer STEM Camps, as well as the Director of the Urban Scholars program where hands-on, project-based activities and gaming teach real-world science and math to middle school students.

Dr. Robert Colesante, Professor of Education, teaches courses in education, educational psychology, and literacy. He has directed or co-directed successful urban youth programs for over 15 years involving hundreds of inner city youth, and over $750,000 in external funding. His research interests include moral development, urban youth development, and use of technology in education. Recent publications appear in the Journal of Moral Education, Journal of Applied Social Psychology and the School Community Journal.

Dr. Albert G. Andrade is a middle school educator at Christian Brothers Academy in Albany, NY and Program Developer for the Urban Scholars Program, a STEM enrichment initiative for middle school students. Dr. Andrade’s interests include the application and development of media and learning technologies to support self-directed and project-based learning experiences. Related interests include the development of programs and materials that support critical thinking and deep literacy across the disciplines, and understanding the impact of information technology on education policy and practice.