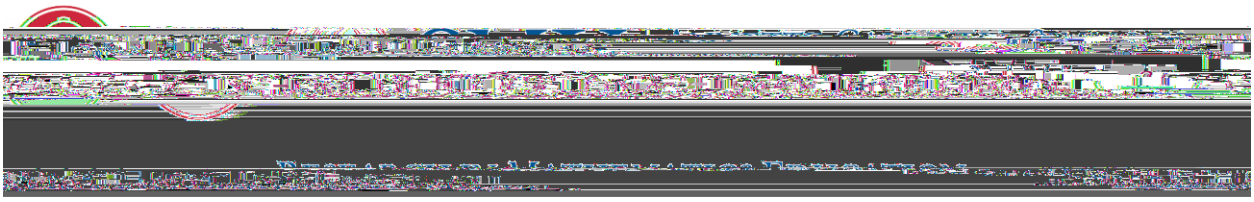

STEM+C Educator Advisory Panel

Summer 2020

RESEARCH IN MATHEMATICS

Technical Report 20-18

STEM+C Educator Advisory Panel Summer 2020

Ching-Yu Tseng Leanne R. Ketterlin Geller Corey Clark Eric Larson

Southern Methodist University

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Department of Education Policy & Leadership
Simmons School of Education & Human Development
PO Box 750114
Dallas, TX 75275-0114
Contact information: rme@smu.edu

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Abstract

Integrating computing into science, technology, engineering, and math (STEM) education at the K-12 level is critical to creating a competitive, innovative workforce that is capable of the computational thinking needs of the future. Efforts to increase intrinsic interest in math and data science have proven difficult to apply evenly across gender, race, and socio-economic factors. The STEM+C research project will assist in creating a more stable, ethical, and inclusive data science workforce by broadening the interest in data science to a more diverse population of students. This research spans the fields of game design, human computer interaction, machine learning, curriculum design and educational assessment by integrating STEM+C based curriculum directly into “Minecraft.” It advances the knowledge in game-based learning by building on techniques and experiences from commercial game design. The game and infrastructure produced through this research will serve as a vital computing resource for middle and high school educators that will be sustained beyond the current project.

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Timeline and Phases

Figure 1. Outline of each phase in the project

The STEM+C project is a four-year plan and divided into five phases. The details of each phase is described below.

Phase 1 Problem

> The goal of Phase 1 is to operate as the planning year. A congregation of the teacher advisory board will allow the team to better understand the problems and seek input from stakeholders around translating math and computing concepts into the gaming platform.

Phase 2 Outline Solution

> The goal of Phase 2 is to develop out and mock up games for the targeted students while looking at the context in which gameplay will be implemented. The team will continue to solicit EAP's feedback throughout this process.

Phase 3 Development

> Develop the core of the Minecraft gameplay and integrate it within the Learning Management System (Canvas).
>
> Although

Integrate all the findings and continue to see how to implement them in the classroom.

Phase 5 Experiment

Studying the use of the gameplay within a specific school system for teachers, for improving students, and for the enjoyment related to students.

Narrowing the Focus across Grades

At the March 2020 meeting, the grade band focus was from sixth to twelfth grade (level 2 and 3). After discussion and based on the analysis and categorization of all standards together, plus the teachers' feedback, researchers narrowed down the grade band focus to sixth to eighth grade (level 1 and level 2). Researchers will refine the proposed grade bands in subsequent EAPs to get feedback from teachers. The intent is for students to concentrate on playing Minecraft as opposed to actual programming. Students may learn some aspects of computer science, moreover, playing Minecraft may give younger students (K-5) a chance to learn about computer science in a relaxed way.

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- **Value of iterative development.** Teachers thought 2-DA-09 could provide the chance for students to think about their model iteratively to understand more about how this world works and to challenge their first model. Also, they know nobody can get it right the first time, and if they want it to be perfect, repeated 'revise and review' of their model is necessary.

- **Concerns about access for all students.** If each student participates in Minecraft gameplay as part of their curriculum, there are opportunities for everyone to learn the content. If not every child participates, teachers will need to come up with alternative curriculum to make sure each student can catch up on the progress.

- **Minecraft may help students apply their knowledge in contextual ways.** The interaction of what they need to learn with the visual part of gameplay may appeal to students' gaming mentality and make learning active. So far, students can't learn by doing or apply their math knowledge in the real world. Integrating these standards into the Minecraft context can give students this valuable practicetegrating

Feedback:

Teachers all agreed that these standards capture the important and difficult to teach, help to free up some space in curriculum, and solve a problem for instruction. Additional themes emerged:

- **The importance to understanding the starting point to solve a problem and the structure behind it.** It's a challenge for students to understand where to begin when solving problems. They have to learn the backbone and the structure of these standards before they can address more complicated things. These standards can help students learn the structure behind all the content and things that they're creating and building, which helps solidify and support other areas. If students can learn this skill in Minecraft before they come to a problem, it definitely can save a lot of time in the classes, because these standards can let students get prepared for continued learning.

- **Concrete thinkers with confidence may have more motivation**. Middle schoolers are concrete thinkers. These standards can give them more confidence to begin this process of how to solve or fix a problem and how to facilitate more design and implementation of what they're trying to do. Also, it'll increase their satisfaction level because students can see how they can work through facing a problem. If gameplay can give students the background knowledge they can utilize and apply it in a new way, they will feel more successful and confident.

Group 3: Organization and Teamwork

The description of Group 3 standards.00000912 0 612 792 reW*nBT/F4 12 Tf1 0 0 1 471.67 546.22 Tm0 fF6 12

Feedback:

Teachers all agreed that these standards capture the most important and difficult concepts to teach, help free up space in the curriculum, and solve a problem for instruction. Additional themes emerged:

- **Learning by doing**

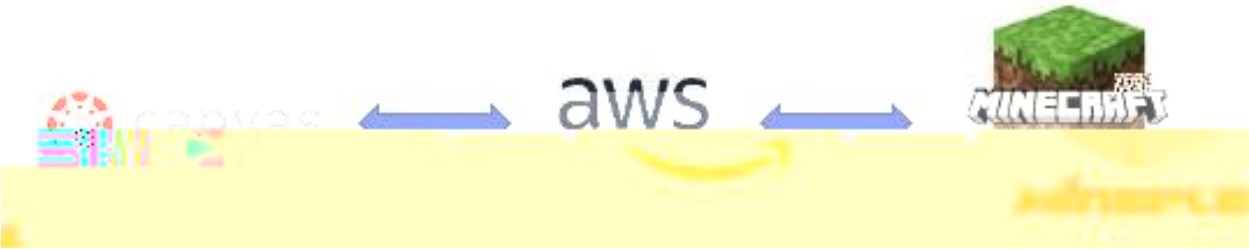
If we integrate these standards, would this help free up some space in your curriculum OR do you already have these integrated into other activities?

If we integrate these standards, does this solve a problem for you?

Feedback:

Integration of Minecraft and Canvas

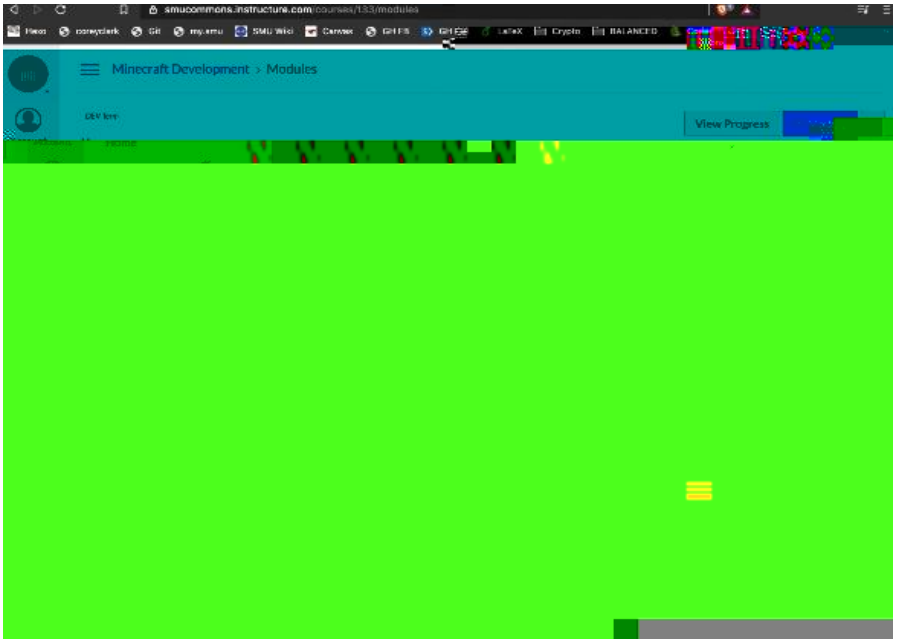
Figure 3. Integration between Canvas and Minecraft.



Teachers can create assignments from Canvas. The workflow follows:

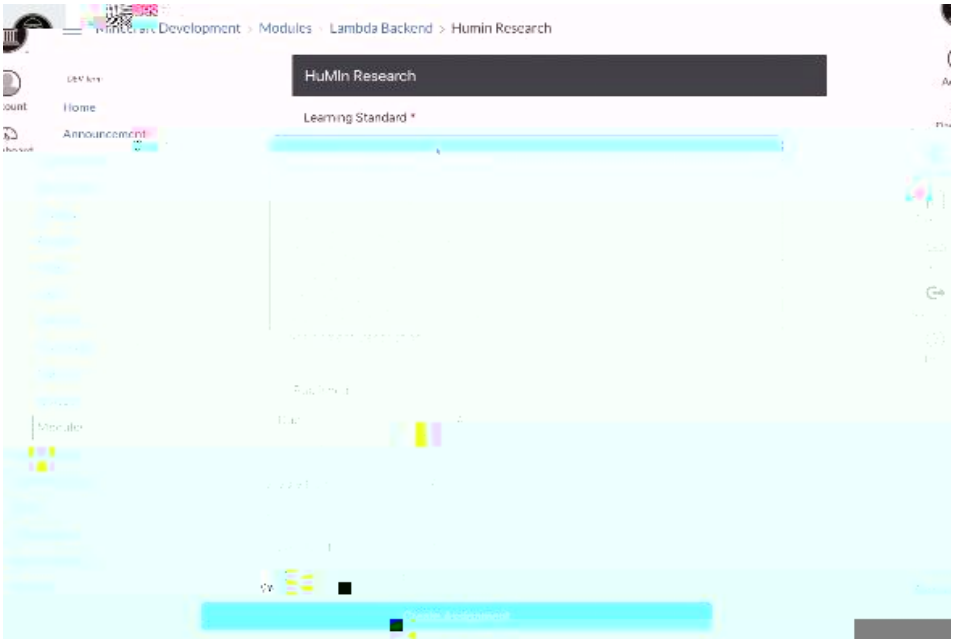
1. Click on the build-in module.

Figure 4. Build-in module in Canvas.



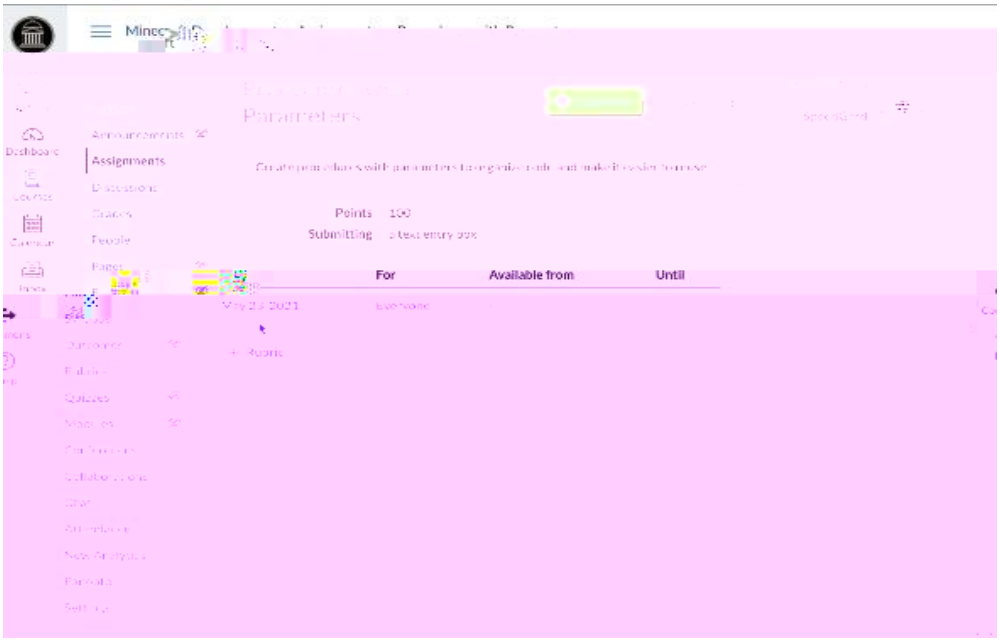
2. There are some standards which are selected in the pull-down menu. Teachers can dropdown any of assignments they want to do, and put the necessary elements for classes in, for instance, the score.

Figure 4. Integration between Canvas and Minecraft.



3. Publish it and set the due date, then click on create the assignment.
4. The LMS system will assign the task to everyone.

Figure 5. Canvas assigns the new task to everyone.



When the assignment is created in Canvas, you can see the item for this assignment will pop into the pre-configured Minecraft world. Every student has their area or group, which depends on how teachers design the task. The system will automatically collect data and information, such as how much water students consume and how many things they build in Minecraft, then send back to their Canvas portal after the task is over.

Figure 6. The item shows up in Minecraft after creating the task.

Teachers can check the LMS to know the details of students' tasks and grade them. Even people who are not familiar with Minecraft still can stay in the LMS to design the assignments and observe all actions students make. This design is for some people who are not technology adopters or not confident with Minecraft can also utilize this system.

Impact and Equity: Students can experience how their decision or action will affect

Therefore, if there are tutorials, videos, or help features can build in the system, it will be handy for teachers to address questions when students get stuck.

Tracking ensuring progress is reaching individual student goals.

Questions arose about how to make sure students really accomplishing certain goals or tasks set up by the teacher and how to know when they're falling short? How to track progress?

Response from STEM+C team: The only way to accomplish the task given to the student is to build something. For example, a task needs to produce a lot of materials, and the only way is to create an automation system to accomplish it. Because students do these works in the game, the system can track each person, know what they did, and what and where they build. Teachers can set up each area for students but only one person can develop in each block. Students can talk and discuss with each other, but eventually, they have to build their own.

The concern about if Canvas has feedback system for teachers and students to remind them where they need to notice.

What will teachers see from the LMS side to give feedback for their students? Or what feedback in the LMS is provided to students to know where they should build more?

Response from STEM+C team: It's one of the key components that there is a 2D space to show your Minecraft simulation. If students don't meet these requirements or results, the 2D simulation will show it in visualized way. The visual feedback can help not only students, but also teachers to understand where they're falling short.

Biographies

EAP Member 1 is