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# AN EARLY SECONDARY MATHEMATICS CURRICULUM INCORPORATING STUDENT INTEREST AND GAMES

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*An early secondary mathematics curriculum was co-designed by a team of teachers, mathematics education researchers, and learning scientists specializing in executive function research. Curriculum designers used feedback from students as well as teacher input to design units that embedded student interest into mathematics content. The curriculum includes content-based games to offer multiple learning opportunities. Teacher interviews were analyzed to gather findings related to student engagement while using this curriculum. The use of games as an engagement and popularization strategy for mathematics education is discussed.*

How do we get more students interested in mathematics? This is the driving question of many math education researchers. There might be different takes on the question, as researchers may focus on developing mathematics context that relates to a certain marginalized racial group or gender (Nasir 2002, Gutstein 2016) or through enhancing teacher training and retention (Olitsky et al. 2020, Zaslavsky et al. 2003). This proposal offers a glimpse into an early secondary mathematics curriculum that aims to capture student interest through student generated context and the usage of content related games. In particular, this proposal will discuss student engagement from the perspective of teachers who used these instructional materials with their students.

The primary research question informing this study was: How do students engage with a curriculum that uses contexts with which they are familiar? One of the goals of the curriculum was to enhance student engagement and learning of key mathematical concepts in algebra and statistics. Teachers played a crucial role in this project, from the development of context/concepts to implementation and revisions. Teacher feedback about necessary changes to the curriculum and their reflections on student learning guided curriculum design for successive iterations of the project.

## THEORETICAL FRAMEWORK

Student engagement is a very broad term so placing context is important for clarity. According to Schneider et al (2016), student engagement happens when tasks are aligned with students' interests, challenging, and relevant to their lives. The things students find interesting are very personal, they can be things students are already familiar with or new concepts that arise from new experiences and interactions. Broader exposure to new ideas with opportunities to integrate them into familiar schema may be beneficial to student learning.

Engagement like Schneider et al's (2016) conceptualization is a basis for our work, but we focus in particular on aspects of interest and relevance. Engagement through general interest will mean a teacher has reported students finding an activity fun or exciting; examples would be interacting with a game, a puzzle, or a task that offers individuality in decision making. Relatability refers to instances where teachers identify that students were able to connect with the material through activities, ideas, and celebrities, and so on that they enjoy engaging with outside of school.

Like many other learning opportunities, the teaching and learning of this mathematics curriculum occurred in a social environment, specifically a classroom. Many scholars have theorized learning as a social practice (Boaler & Greeno 2000, Lampert 1990). To that end, community engagement was included as a theme when analyzing student engagement with this curriculum and specific instructional activities. We consider community engagement as instances where teachers reflected on students participating in activities as a whole group or in small groups.

## METHODS

The curriculum was designed using input from a group of teachers, mathematics education researchers and graduate students. Teachers informally polled students about what contexts they might be interested in and relayed those interests to the design team to blend those interests into content. Using this information, the team tapped into sociocultural norms of early secondary students by creating context centered around American pop culture figures and relevant situations, like food shopping. The team used the Common Core Sixth Grade Mathematics Standards (National Governors Association Center for Best Practices & Council of Chief State School Officers 2010) in the United States to inform content decisions. The tasks were a combination of open-ended questions, conceptual style questions, and a few procedural questions. One of the contexts used to teach histograms was Twitter data collected from Billie Eilish and the Weeknd, two influential music singers. The students used the given data which from each singers' recent retweet count to create histograms and describe measures of central tendency. An algebra lesson used fabricated orders from McDonald's menus to create and solve expressions related to total order weight.

Members of the curricular design team included executive function (EF) researchers who were tasked with embedding EF content into the curriculum. The EF team created several interactive games that leveraged mathematical concepts like ratios, expressions and equations, and strategies for finding the mean of a set of numbers. The research team created a digital version of the games, which were also available for students to play. The card games created were all original, but one of them was an extension from the game Uno. The project team's version of the game included cards with variables and expressions. These additional cards were playable based off the value of the variable, which is decided by other cards that could be played out of a players' hand.

Teacher interview data of five teachers from a secondary school in a suburban district in the Midwestern United States was coded for instances where teachers mentioned and described student engagement with curriculum (content and context), student engagement with the games, and how students interacted with each other. Examples of some of the interview questions were: "How did your students respond to the problem contexts and activities?" and "What were your favorite/least favorite parts of this unit?" Three of these teachers were interviewed twice, once after the first unit implementation and the second time after the second unit implementation. The researcher used a coding scheme that focused on keywords, specifically when teachers mentioned student engagement/disengagement, enjoyment, relatability, interest, groupwork, etc.

## RESULTS

The analysis shows 44 mentions of positive student engagement throughout the eight interviews that were conducted (see Table 1). Twenty-four of these mentions were related to students' interest in the

activity, while relatability and community had ten mentions each. In the transcripts, there were two mentions of students experiencing negative engagement with the activities.

| Teacher | positive engagement (relatability | positive engagement (community) | positive engagement (interest) | negative engagement |
|---|---|---|---|---|
| Teacher 1** | 7 | 3 | 3 | 0 |
| Teacher 2** | 2 | 2 | 5 | 0 |
| Teacher 3* | 0 | 2 | 7 | 1 |
| Teacher 4* | 1 | 0 | 3 | 0 |
| Teacher 5** | 0 | 3 | 6 | 1 |

Table 1: Number of mentions of the different aspects of engagement. The number of asterisks indicate the number of teacher interviews.

Most of the teachers' mentions of interest and community were related to students playing games. Teacher 3 stated that she "had a group of kids that really liked playing it (card game) and would ask to play it when they had downtime." Teacher 1 stated that for her students "any kind of game play was great" for engagement. Teacher 2 noticed students "like playing games…instead of me doing notes…so they like playing the game and kind of having their own little freedom." Teachers also discussed aspects of community engagement, such as Teacher 2 who noted, "They love playing with a group." The ability to play the games with classmates, virtually, was an update request for the software that students shared with Teacher 5.

As mentioned earlier, one of the goals of this curriculum project was to increase student engagement in mathematics through relatability by designing instructional sequences that reflected contexts based on students' interests; this information was gathered through student and teacher surveys. The project team and co-design teachers brainstormed ways to relate students' requests to the grade-specific mathematics content standards. Several of the teacher participants were co-design partners and Teacher 1 described how this was accomplished when she summarized:

> "The relatability that you guys created where they can just relate to it that prior knowledge that you guys have created within that student work, I think, is a must, that that engagement side is fantastic".

Nasir (2002) points to the importance of culture, identity and goal setting as key aspects of learning. The ability to tap into student's prior knowledge and context expertise assists in their learning and engagement, especially when that prior knowledge is related to one's culture or identity.

On the other hand, teachers 3 and 5 mentioned some aspects of student disengagement in response to the instructional activities. Teacher 5 noted that the fast-food context "was doing a lot" – e.g., taking up too much time to set up the mathematics – so she decided to "cut some of this out here. The kids are bored." This teacher did not elaborate on whether the content or the context was the boring factor. Teacher 3 discussed her students' difficulties engaging with a virtual simulation involving the distances of a kicked soccer ball, which was designed to show how to visualize mean and median on a graph. Her students "weren't really buying into it much. I don't think they understood what to do." These two instances were the only mentions of disengagement related to the curriculum. Teachers'

discussion of student behaviors due to the upcoming end of the school year were not included in this analysis.

## DISCUSSION

These results suggest that generating student interest, relatability, and community through aspects of popularizing mathematics, such as student generated problem contexts and games was achieved. Other studies have pointed to the success of relevant context in classrooms (Nasir 2002), so the large proportion of mentions of engagement in the community aspect was unexpected. Mathematics teaching reform efforts in the United States have called for more eliciting of student responses; one of such ways to accomplish this is through student discourse (NCTM, 2014). Mathematics games provide an opportunity for students to work together in a unique way that can be collaborative or competitive depending on the structure. This collaboration allows students to discuss their ideas with a small group of peers which can be less intimidating than with a whole group. Games also allow for a lower stress environment to try new things and make mistakes that lead to enhanced learning. Using games as a legitimate teaching strategy, instead of exclusively using them as fun review activities, may be beneficial in engaging students in learning of mathematical content at any stage of their development.

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