# MathSpark: Sparking student curiosity through hands-on, inquiry-based mathematics explorations inspired by funds of knowledge

Katrina Baha, Kaliyah Clyde, Mikaela Morris,
Dr. Perla Myers and Dr. Amanda Ruiz

University of San Diego®

## Abstract

Much of the existing research focuses on the questions teachers ask students, but there is very little information about the questions students ask. The main purpose of this research was to explore ways to engage students in asking their own questions in the learning of mathematics, and to create a scale to help educators categorize the types of questions students ask. We created and used inquiry-based, funds of knowledge-rich lessons with productive struggle opportunities to promote curiosity (Calleja, 2016) and elicit student questions to develop and test our question categorization scale.

## Background

Our team researched common challenges in student learning, as well as strategies that can help address these issues and enhance the learning experience. We explored: 1) inquiry-based learning, which centers students in the learning process; 2) the importance of the funds of knowledge students and their families bring, which give the students agency by honoring their own culture, skills, and life experiences (Vélez-Ibáñez et al, 1992); 3) the benefits of having students engage in productive struggle during their learning, which also fires their curiosity as they are trying to learn or problem-solve; 4) question-categorization scales, mostly ones created to categorize questions teachers ask. We developed a question categorization scale based on Bloom's Taxonomy and the Van Hiele Levels, and explored how our question categorization scale operates in a mathematics classroom by creating and implementing inquiry-based, funds of knowledge-rich lessons with opportunities for productive struggle in order to stimulate the students' curiosity and create an environment with more reasons and motivation for the students to ask questions. These strategies resulted in more questions than students might usually ask in a mathematics setting, suggesting that they were curious about the topics, leading to further engagement.

## Our 3 Lessons

**1) Game of Life** (Gardner, 1970): a cellular automaton that revolves around the states of the cells on a grid during multiple iterations. Students made observations and predicted future iterations.
**2) Fraction Representations**: Students engaged in several activities to realize that a single fraction can be represented in many different ways.
**3) Origami**: Students explored questions while folding paper and engaging in productive struggle to make a sonobe cube.

## Our Question Categorization Scale

I. Recognize II. Remember III. Comprehend
IV. Analyze V. Apply VI. Create

## Demographics and Results

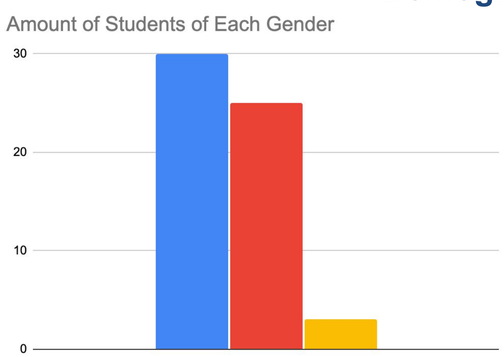


Figure 1

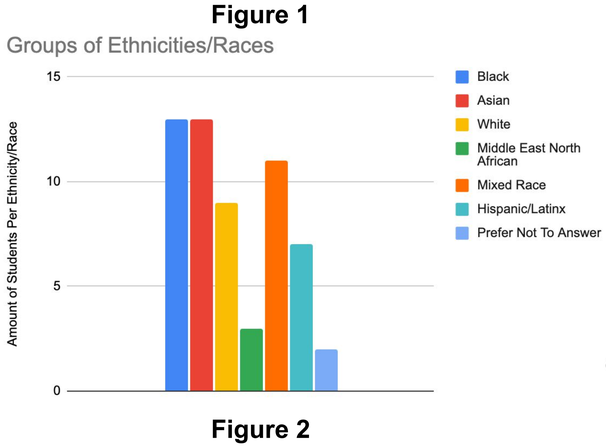


Figure 2

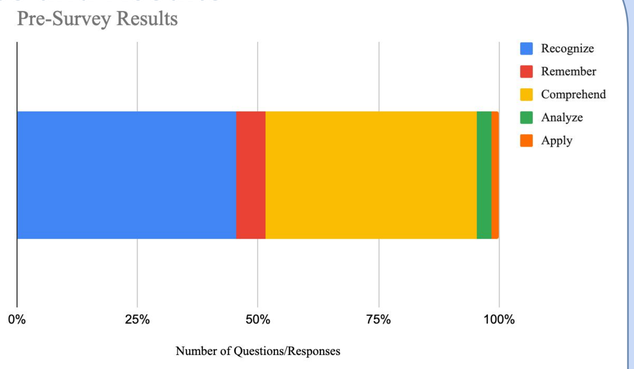


Figure 3

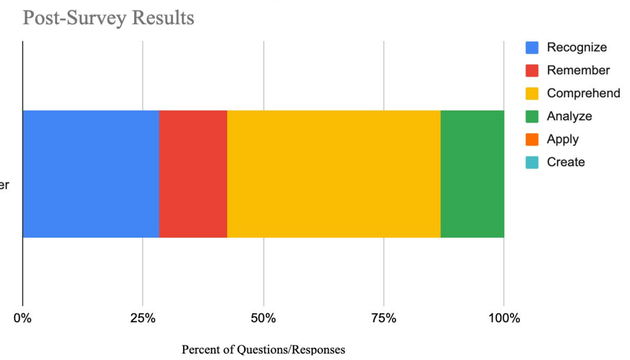


Figure 4

**Figure 1**. Number of male, female, and students who identify with other gender identities at STEAM Academy.
**Figure 2.** Student ethnicities/races at the STEAM Academy.
**Figure 3.** Percentage of questions of different categories written by the STEAM Academy students in the pre-survey.
**Figure 4.** Percentage of questions of different categories written by the STEAM Academy students in the post-survey.

## Conclusions

1. Our results suggest that after engaging in inquiry-based, funds of knowledge-rich lessons with productive struggle opportunities, students asked more higher-cognitive level questions.
2. To generate student questions, it is crucial to develop lessons and methods that help students become more comfortable with questioning.
3. Apply and Create level questions were mostly absent in the student questions.
-We prompted student questions by asking them to write down sentences starting with "I think, I notice, and I wonder." The prompt might not have inspired students to write Apply or Create level questions. Students might have considered responses at the Apply and Create level if we had asked them to find an application of the image from the survey or create their own conjectures.
-We collectively taught 8 times for 45 to 90 minutes per lesson in this 2-week camp. More instruction time may be needed for students to ask Apply or Create level questions.
4. In research settings with students, it is important to ensure that the data collection is organized so that the data is adequate/reliable.

## Citations

Calleja, James. (2016). Teaching Mathematics through Inquiry A Continuing Professional Development Programme Design. Journal of the International Society for Design and Development in Education.
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