

# Empowering Students with Choice through Equitable and Interactive Mathematical Modeling (EIM2)

Award # 2200928

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## Context of Our Work

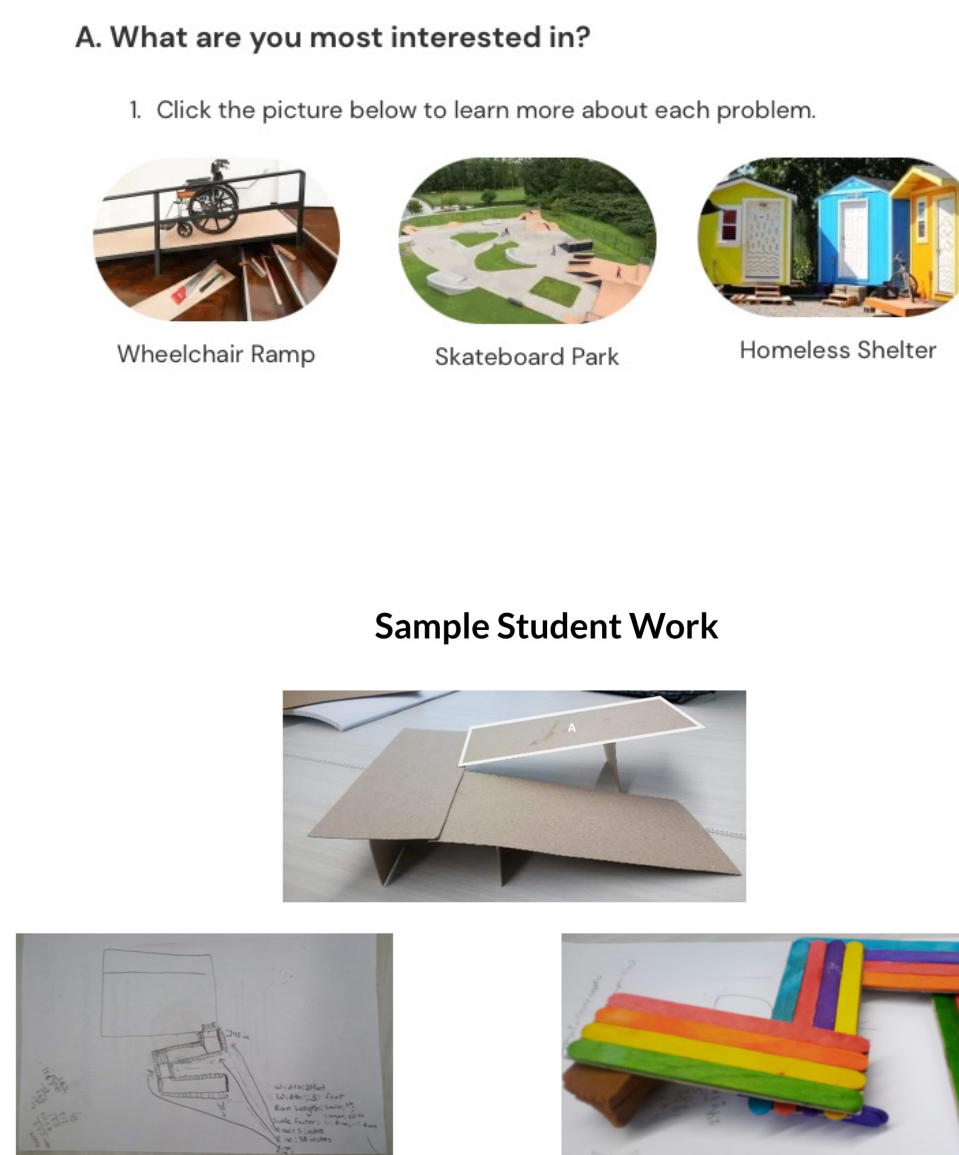
- This Early Stage Design and Development project in the Learning Strand aims to create and study the Equitable and Interactive Mathematical Modeling (EIM2) program, which positions 6th and 7th grade students as decision makers in their own learning as they recognize and celebrate mathematical dimensions of their home cultures in a classroom setting.
- Mathematical modeling invites students to actively design, test, and modify mathematical lenses to solve real-life problems (Lesh & Doerr, 2003). With a free, dynamic online platform and a sociocritical mathematical modeling perspective—a process of using mathematics to understand the life experiences of students and challenge the existing social order
- Through EIM2, students will collaboratively compare and analyze diverse perspectives to reach a conclusion and share it with a broader audience.

## Data Collection and Analysis

Fig.4

	Year 1		Year 2		Year 3		Year 4	
	Fall	Spring	Summer	Fall	Spring	Summer	Fall	Spring
Gather lived experience scenarios from students								
Develop and refine the modules								
Collect multiple solutions from students								
EIM <sub>2</sub> Video Production								
Professional Learning Community (PLC)								
Implement the modules								

## Community Design



## Key Outcomes

### A. PLC Series:

- For the first PLC, we shared the goals and big ideas of the project, discussed potential benefits for teachers, students, researchers, and communities, and shared ideas for building relationships in the classrooms. The teachers noticed the benefits of the project, which included "making choices of their own learning, connecting modeling activities with student voice and what students care about, building a positive association with math."
- During the second PLC, we shared the draft of the first modeling task, Homeless Shelter Task. We engaged them in learning about the task and discussed features of the task. We also discussed potential approaches to improve the task to support their students. After the PLC, we visited the teachers' classrooms and co-implemented the task.
- Third PLC focused on reflecting on the implementation of the homeless modeling task. We also started brainstorming the design of a new task reflecting on the features of the modeling task.
- During the fourth PLC, we shared another example of equitable mathematical modeling task and discussed the features of the task. We continued to brainstorm ideas for a new task, which resulted in ideas for busing problems.
- The fifth PLC focused on the draft online platform and video scripts, inviting them to become virtual teachers who create video clips with the research team.
- During the sixth PLC, we discussed the draft ideas for Summer PLC and reviewed the two additional modeling tasks for video production.
- Each PLC was closely aligned with the teaching-research goals, inviting teachers as partners in decision making of the entire process.

### B. Interviews:

- Almost every student who was interviewed described both their nuclear and extended family as an extremely important presence in their life.
- Other prominent themes that emerged included spending time with friends, engaging in sports, being outside, using social media platforms, such as YouTube and TikTok, and discussing relevant real-world events, such as homelessness and persons with disabilities.
- Two social justice tasks that were created that incorporated students' lived experiences were The Wheelchair Ramp Modeling Task and Temporary Skate-Safe Area Modeling Task.
- An AMTE proposal titled Becoming Familiar with Middle School Students' Life Experiences as a Bridge For Engagement and Motivation that utilized this data was submitted in May 2023.

### C. EIM2 Tasks Design and Implementation:

- Conducted pilot testing for the three modeling tasks with a group of 6th and 7th grade students.
- The feedback we received from the students helped us enhance the activities by incorporating new features.
- The wheelchair ramp activity, along with its theoretical foundation, will be presented at the upcoming FCTM 2023 conference in Orlando, FL. It will be showcased as a workshop where Florida teachers will have the opportunity to test it out and provide valuable feedback regarding its practical application in the classroom.

### D. Video Production:

- The three scenarios/problems were turned into a script for the teachers to read in a video.
- All the imagery that accompanied the scenarios/problems was incorporated into the videos.
- Two local teachers - a black female and a white female - recorded the videos at the ETC studio.
- For the student-led solution approach videos, seven students from local schools participated: two Black females, one Black male, one Latinx male, and three Asian males. All of these students participated in the task solution focus groups.
- Their work was turned into a script and visuals to be used in the videos. All the students recorded the videos at the ETC studio.
- ETC completed all the post-production work for both the teachers and students set of videos, and engaged in a productive feedback cycle with our team to make sure the final product fulfilled our vision and objectives.

### E. Surveys:

- The adapted survey was deemed appropriate for sixth grade students. Students were not confused by any items.
- Although students said the items were worded clearly, they recognized that their response "depended" on some contexts (e.g., level of problem difficulty, strategies taught or encouraged by their teachers, their knowledge and/or comfort level with certain math concepts).
- It was not practical for us to add an option of "It depends" because we wished for the adapted survey items and responses to closely correspond to the survey items by Kaspersen et al.
- We added some additional items that probe students' thoughts about context as well as global items about their math identity, which can be used to validate the adapted survey items.

## Project Overall and Year 1 Goals

- Explore the nature and impact of the EIM2 program, which promotes a shared vision for the learning of all students in a classroom setting.
- Examine whether and how students' engagement in the EIM2 program supports their identities and achievements in mathematics.
- Understand how teachers enact EIM2 modules and whether they change their attitudes toward modeling over time and across contexts.

In the first year of the project, our main goals include:

- Professional Learning Community (PLC) Series:** Establishing relations with schools and collaborating with teachers through PLC Series.
- Interviews:** Conduct interviews with students to identify resources for mathematical interest and identity.
- Equitable and Interactive Mathematical Modeling (EIM2) Tasks Design and Implementation:** Developing and testing three activities for the first EIM2 module.
- Video Production:** Developing and refining the videos and website elements that comprise this module.
- Surveys:** Refining and programming surveys about teachers' attitudes toward modeling and students' identity development.

## Year 1 Results

### A. Professional Learning Community (PLC) Series:

We invited the teachers to participate in a monthly professional learning community(PLC) series, consisting of six sessions, each lasting one hour. Additionally, we organized a Summer PLC that spanned three days, with each day comprising six hours.

### B. Interviews:

Semi-structured interviews were conducted with 15 local 6th and 7th graders to gather information on their individual lived experiences and out-of-school interests. Using the constant comparison method, interview transcripts were analyzed and coded focusing on themes that consistently emerged.

### C. Equitable and Interactive Mathematical Modeling (EIM2) Tasks Design and Implementation:

We designed three modeling tasks using the principles for the design of equitable mathematical modeling tasks that put together Ladson-Billings' (1995) culturally relevant pedagogy and Lesh et al.'s (2000) framework for the design of modeling-eliciting activities. Homeless microshelter, Wheelchair ramps, and Temporary skate-safe area tasks are two prime examples of how mathematical modeling tasks can foster equity and social justice.

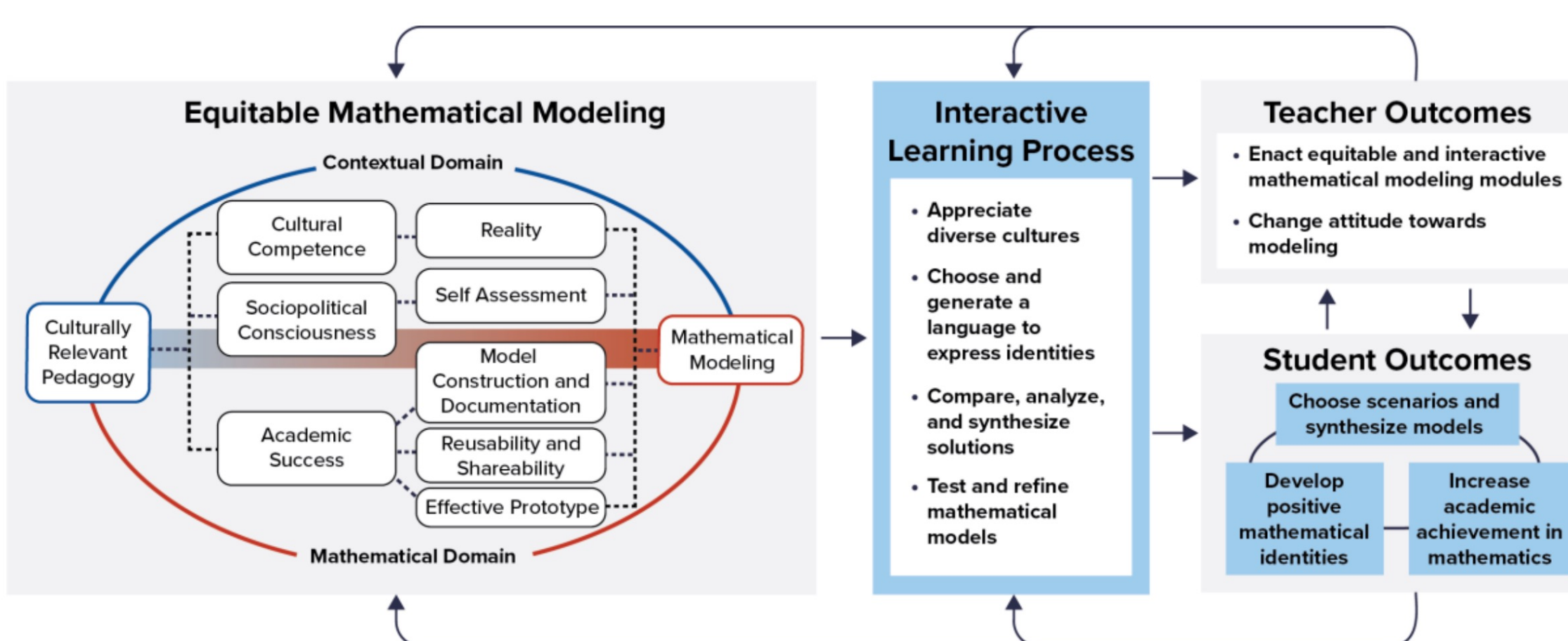
### D. Video Production:

Videos produced by the E-Learning, Technology, & Creative Services team (ETC) at the College of Education bring to life both the context and solution strategies of the three modeling scenarios. Teacher videos contain narration, visuals, and data of the problem context introduced by either one of two EIM2's virtual teachers. Student videos were recorded by the same students who participated in the modeling task solution focus groups. Each student presented their own mathematization approach from the perspective of their problem solving team that has adopted that approach or their own individual perspective.

### E. Surveys:

We have adapted the students' mathematical identity survey by Kaspersen, Pepin, & Sikko (2017) and Kaspersen & Ytterhaug (2020) to be more appropriate for middle-school students. We conducted video-recorded interviews with four sixth grade students. Students were asked to complete the survey at the beginning of the interviews/focus groups while we watched their survey-taking behaviors. We tracked students' responses during the interviews/focus groups by noting their responses for each item on a spreadsheet. We then watched the video recordings to take additional notes. Finally, we emailed the original survey author (Kaspersen) to receive his feedback on our adapted survey and findings.

## Research Design: EIM2 Theory of Action



## Impact and Dissemination

- The proposed project fills a theoretical gap related to scalable design models for interactive mathematical modeling curricula that are culturally sustaining for students.
- Our model of learning processes and design principles have been tested and refined through multiple iterations to ensure usability and efficacy.
- We have been investigating how our approach of leveraging students' decision-making in learning mathematics supports their development of positive mathematical identities.
- Our model improves upon current practices of mathematical modeling by transforming existing curricula to reflect students' lived experiences and foster their active learning, leveraging the interactive nature of digital curricula.
- Our work has the potential to be transformative for STEM education through the co-creation of asset-based instructional materials built on a deep understanding of students, which can be applicable for other STEM education fields of study.
- EIM2 fosters mathematical modeling in an interactive and culturally sustaining context, responding to problems that have been reported in several previous educational studies and practices. We have conducted multi-tier design-based research to facilitate the refinement of our EIM2 program. The program development have been guided by design principles and hypothesized learning processes that support students' cultural competence, their evaluations of multiple mathematical solutions, and their mathematical identity development.

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