Integrated Data Project: The Interdisciplinary Practice of Explaining Variability During Middle Grades Math and Science Investigations

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CAREER: Supporting Model Based Inference as an Integrated Effort Between Mathematics and Science
#1942770

Introduction & Background

Motivating Problem

Students need a coherent experience across math and science when learning to make claims with data.

Project Goals

1) Design investigations that coordinate learning experiences across math and science classes
2) Develop design principles and knowledge about students' data modeling practices

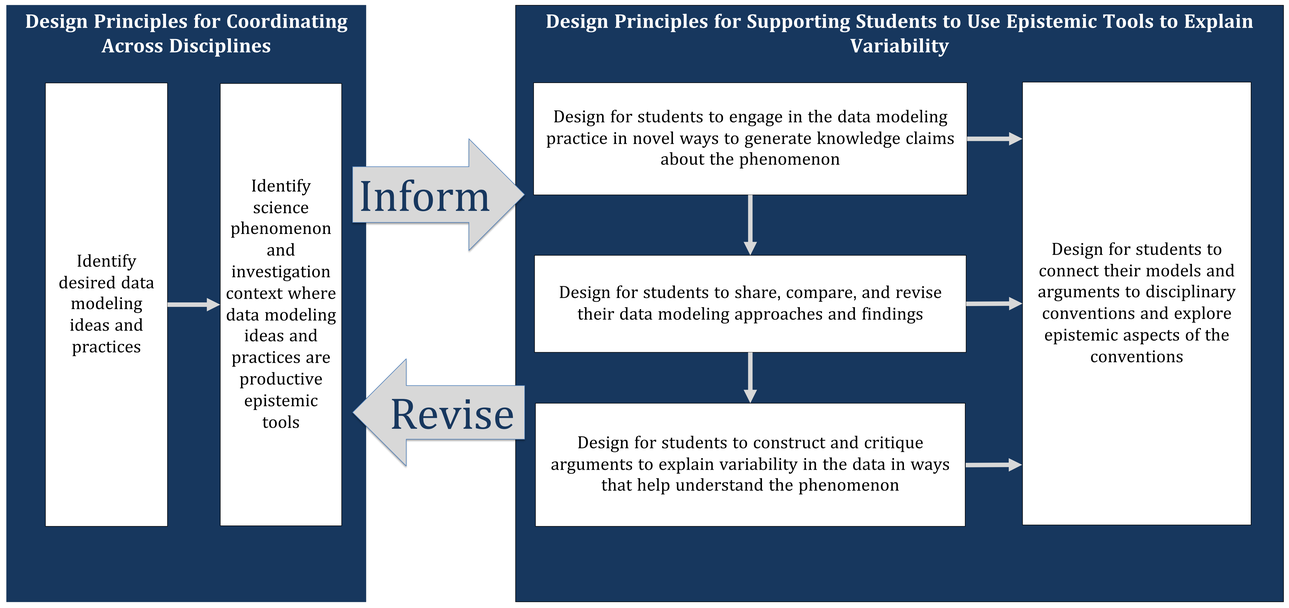
Context & Methods

We use Design Based Research methods in partnership with one middle school in the south-central region of the USA. The school serves an ethnically and economically diverse population of ~1,000 students. Partner math teachers have used Dr. Richard Lehrer's *Data Modeling* curriculum for 5 years. Partner science teachers have received no previous support in helping students make inferences with data.

Motivating Literature & Theory

1) Data modeling is the practice of making claims in the midst of a ***variable world*** (Lehrer & Schauble, 2004; Lehrer & English, 2018; Petrosino, et al., 2003; Bargagliotti, et al., 2021).
2) This practice requires a coherent coordination of an ***interdisciplinary*** set of ideas (Cobb & Moore, 1997; Rodgers, 2010; Wild, et al., 2018).
3) Students should be supported to see these ideas and practices as ***epistemic tools*** to generate claims and to use them in ways that are epistemically congruent with professional practices (Forman & Ford 2014; Ford, 2015; Manz 2015; Manz 2020).

Integrated Data Project Design Framework



Tentative Findings

Partner Math & Science Teachers

1) Our teachers have a strong spoken desire to engage their students with data in meaningful ways, and regularly describe this as a goal for students to "see" with data.
2) While teachers universally desire students to "see" with data, they have different goals for what they want students to see. Sometimes they want students to see data shape, trends, or conventional explanatory models in data in fairly unproblematic ways. Other times they describe a desire for students to see complexity, uncertainty, and human agency in data models and arguments. We hypothesize these two perspectives have implications for instruction.

Coordinating 6th Grade Data Investigations

1) Many science learning goals rely on multivariate reasoning due to a focus on relationships within an explanatory model (e.g. relationship between organism growth and environmental factors). We have found the most fruitful points of coordination between math and science classes in 6th grade emerge from valuable science questions that require meaningful grappling with variation in univariate data (e.g. characterizing a population of organisms)
2) Students constructed increasingly detailed explanations of variation across math and science classes. These explanations were supported by innovative visualizations and statistics that helped students explore the magnitude of different sources of variation such as measurement error, environmental factors, and time.

Coordinating Math and Science Investigations to Explain Variability

Developing epistemic tools to explain variability

Modeling differences

Explaining differences

Structuring differences

Measuring differences

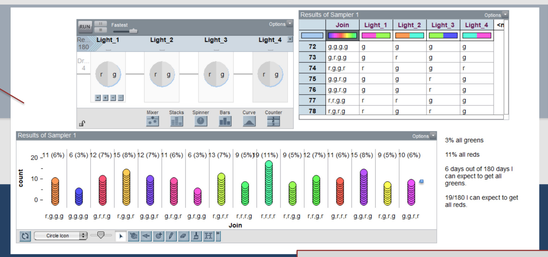
Describing differences

Math Class
How can we make claims with all this variability?

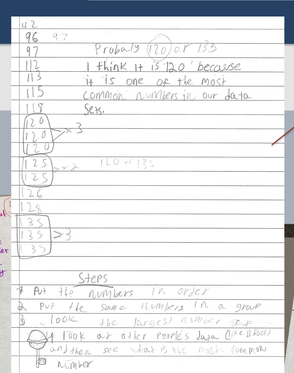
Student model simulating teachers' drive time to school and distribution of outcomes across 180 simulated drives.

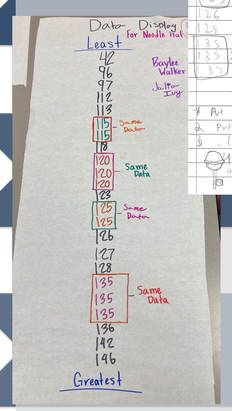
"6 days out of 180 days I can expect to get all green"

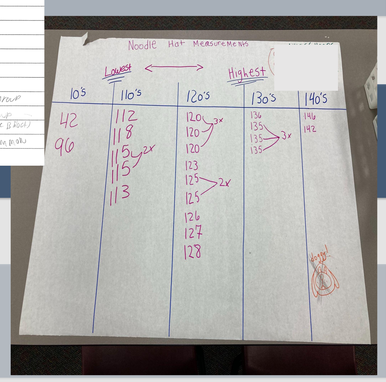
"19/180 I can expect to get all red."



Student invented data visualizations and statistics generated in response to the question "how long is the object we all independently measured?" (Tasks from Dr. Lehrer's Data Modeling curriculum)

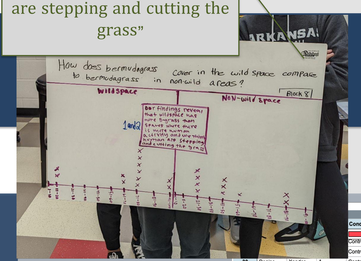


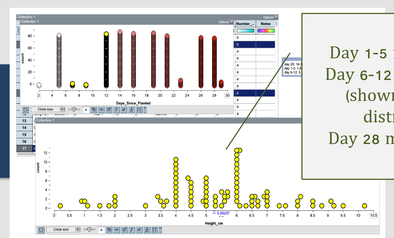




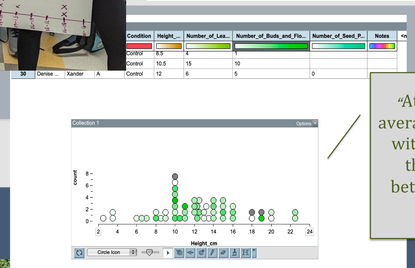
Science Class
How do plants change as they grow?

"The wild space has more B-grass than spaces where there is more human activity and we think the humans are stepping and cutting the grass"





Day 1-5 mean = 1.805
Day 6-12 mean = 5.262 (shown in yellow distribution)
Day 28 mean = 14.808



"At first we thought the average would be 21, but … with multiple classes we think it is 12 because between 10 and 14 is the highest"