Assessing Mathematical Sensemaking in Science across Disciplines

Kevin Haudek[1], Amber Armstrong[2], Melanie Cooper[1], Michael Fleming[3], Sage Foster[1], Rachel Henderson[1], Jennifer J. Kaplan[4], Veeda Scammahorn[1], Anita Schuchardt[2]

[1] Michigan State University, [2] University of Minnesota - Twin Cities, [3] California State University - Stanislaus, [4] Middle Tennessee State University

Rationale

Current visions for undergraduate STEM education focus on integrating key disciplinary ideas and crosscutting concepts with authentic scientific practices, leading to three-dimensional learning (3DL). Sensemaking is broadly defined as using prior knowledge to understand a new concept, solve problems, or develop mechanistic explanations Although Mathematical Sensemaking has been explored within individual science disciplines, this project engages interdisciplinary research to investigate how undergraduates use this sensemaking across biology, chemistry, and physics. Our project team includes discipline-based education researchers from biology, chemistry, mathematics, and physics.

Project Goal

We are working to understand how undergraduates engage in mathematical sensemaking across science disciplines when explaining and solving computational problems as part of 3D learning.

Approach

- Use mECD to design assessments which can elicit evidence of 3D learning
- Evaluate responses for evidence of 3D learning
- Use Sci-Math Sensemaking framework as a fine grained approach to explore how students make connections between math & science ideas

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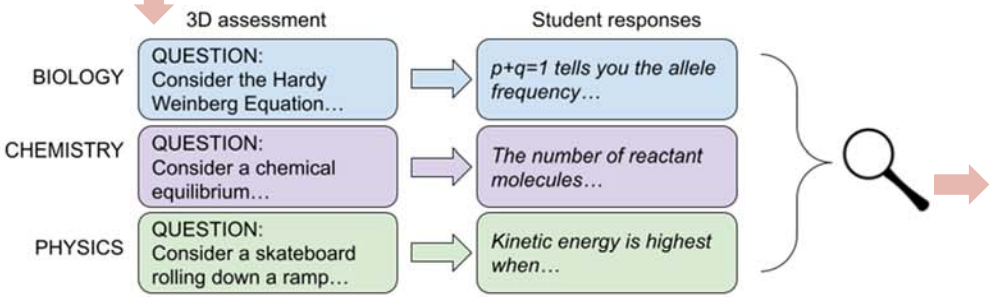
What is 3D Learning?

- Three dimensional learning integrates key disciplinary ideas, scientific practices and cross cutting concepts to help students engage in science around real-world phenomena.
- When these 3 dimensions are integrated in courses it can help students build usable knowledge to transfer to new contexts and lead to meaningful learning.
- We construct 3D assessments to provide evidence of 3D learning
- We focus on two scientific practices: ***Using Mathematics & Computational Thinking*** and ***Constructing Explanations***.

From Cooper et al. (2024)



Domain	Category
Mathematics	Procedure
	Rule
	Structure
	Relation
	Concept
Science	Label
	Description
	Pattern
	Mechanism

From Zhao & Schuchardt (2021)

What is Science-Math Sensemaking?

- Students engage in sensemaking during learning as they encounter new contexts, are confronted with gaps in knowledge or presented with a conflict that requires explanation or resolution.
- Sensemaking can be done in support of 3D learning, as students build and revise explanations.
- Previous work has shown different kinds of sensemaking across and between science and math domains (***Sci-Math Sensemaking***)
- We use this Sci-Math framework to investigate student responses to explore what sensemaking occurs as they are engaged in 3D learning.

Developing Collective Perspective in an Interdisciplinary Team

- As an interdisciplinary team we all agree that Mathematics & Science are connected, but hold different views on which may be supportive of the other.
- Over the first year of the project, we have spent time as an interdisciplinary team exploring:
  - Common ways mathematics are used across disciplines and reconciling disparate view of math in the disciplines
  - Reconciling the affordances of the 3D learning framework, especially the practice of Using Mathematics & Computational Thinking, with the Sci-Math Sensemaking framework
  - How do the different forms of Sci-Math sensemaking elicited from students interact during 3D learning?
  - Struggles with instructional gaps. Although instructors say they value sensemaking for their students, relatively few incorporate sensemaking activities.
- Our long term vision is to use the results of the developed assessments in support of instructional practices that foster mathematical sensemaking across the science disciplines.