Scientific Model Evaluation During a Gallery Walk

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Problem statement:

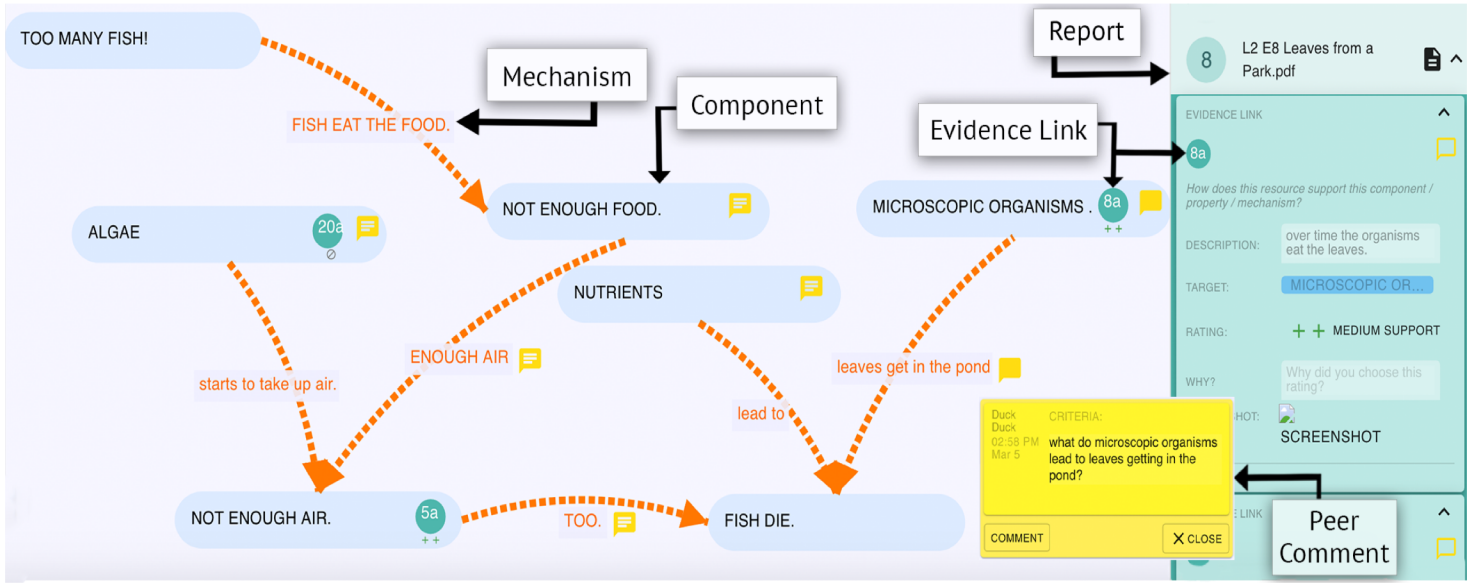
- Modeling is a key scientific practice *(Lehrer & Schauble, 2006; NRC, 2013)*
- Modeling is challenging, and students struggle to *(Pierson et al., 2017; Schwartz et al., 2009)*:
  - Iterate and revise
  - Use normative criteria for evaluating models
  - Use evidence as their motivation for revision
- Visual modeling tools such as concept maps can help students rapidly build and revise their models *(Schwendimann, 2015)*
- Negotiating criteria can support students in recognizing their value *(Duncan, Chinn & Barzilai, 2018)*

The Modeling and Evidence Mapping Environment (MEME)

Eutrophication problem: *Algae grows due to influx of nutrients, algal bloom leads to dead matter and decomposers using oxygen, leads to fish deaths*

Design Features

1. **Phenomena-Mechanism-Component Framing** *(Eberbach, Hmelo-Silver et al., 2021)*
2. **Easy, iterative modeling**
3. **Integrated explicit links to evidence** *(Sandoval & Reiser, 2004)*
4. **Commenting for feedback and discussion**



The MEME source code is open source and available at: https://gitlab.com/inq-seeds/boilerplate

Methods

Participants:

- 19 5th grade students (4 female)
- Public school in the mid-west
- Students in dyads with shared laptop

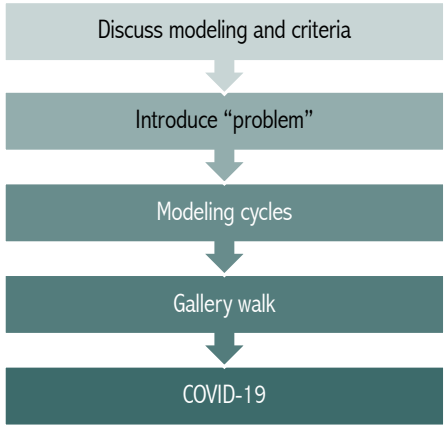
Research Questions:

1. What aspects of peers' models do students orient towards in giving feedback?
2. How did students engage with evidence as an important modeling criterion?

Data:

1. Video of classroom and small groups
2. Screen capture
3. Logs of MEME use

Activity Sequence:



Coding scheme:

Sensemaking
- Opening evidence
- Discussing model
- Discussing comment
- Discussing evidence link

Hole finding
- Ask for explanation *(talk / text)*
- Probe for evidence (*talk / text*)
- Call for evidence (*talk / text*)

Justification with evidence
- Citing evidence (*talk / text*)
- Other rationale (*talk / text*)

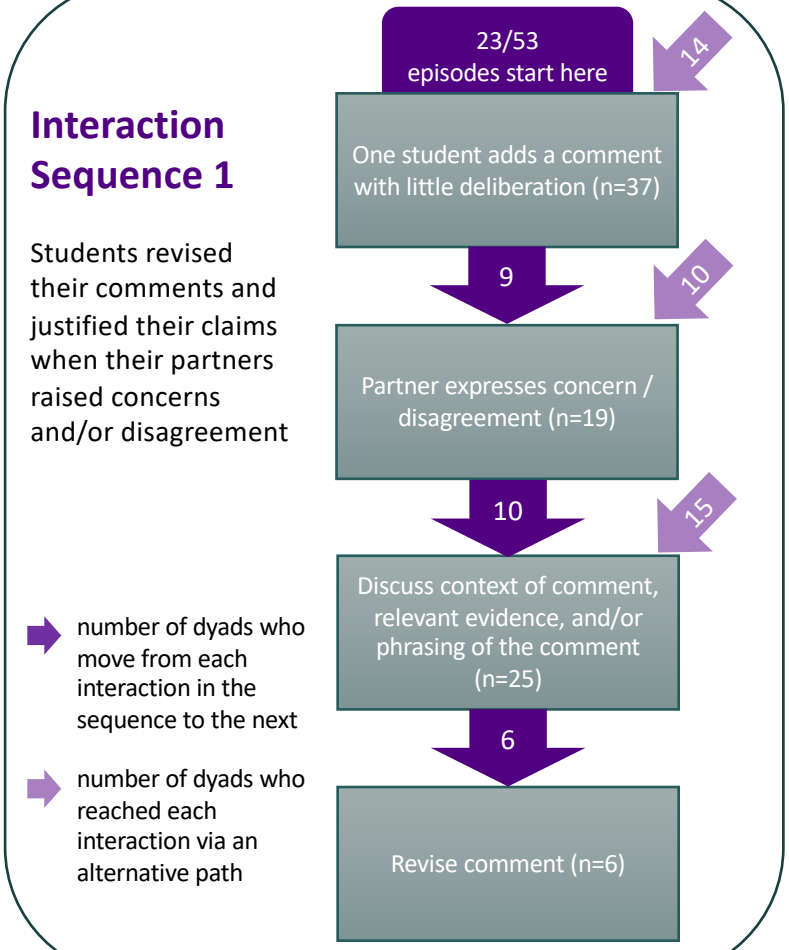
Identify Interaction Sequences:

1. Created and refined visualizations of key moves using codes
2. Use visuals to identify patterns and key moments
3. Count key moments and identify range of sequences to get to them
4. Used interaction analysis to explore implications of those patterns

Findings

Interaction Sequence 1

Students revised their comments and justified their claims when their partners raised concerns and/or disagreement



number of dyads who move from each interaction in the sequence to the next

number of dyads who reached each interaction via an alternative path

Example of Interaction Sequence 1

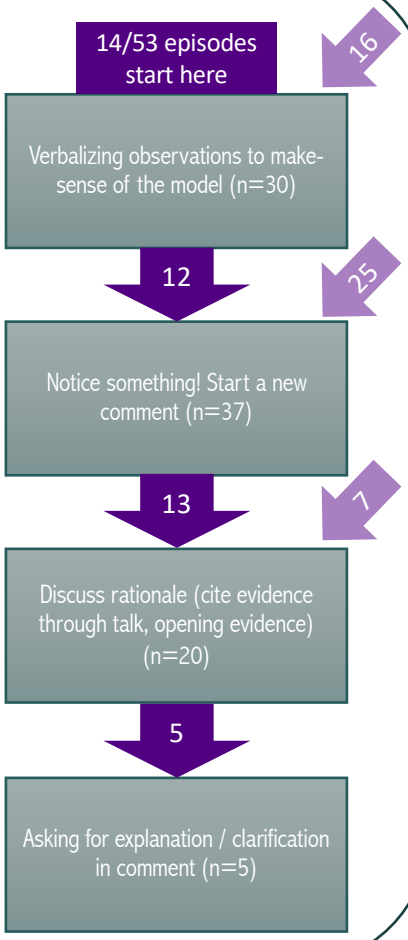
1	Evan:	Should we add right here? (Indicates "pollution" component with cursor on peer's model)	
2	Luke:	I don't know	
3	Evan:	(Selects pollution component and begins to comment by typing, "why did you add pollution in the video there was no pollution in the water")	Adds comment
4	Luke:	How do you know in the video there was no pollution in the water?	Expressing disagreement
5	Evan:	Because I looked at the water	
6	Luke:	Pollution could be at the bottom of the ocean Don't add video (Evan erases his comment, both students stare at the empty comment box)	Discuss relevant evidence
7	Evan:	Fine (pauses, and then emphasizes) I *think* (Starts typing: "I think there was no pollution in the water how would the fish die")	Revises phrasing of comment to include qualifier
8	Luke:	Okay. (Evan finishes typing, classifies it as a critique of 'necessity,' and submits the comment)	Criteria applied

These types of comments lead to re-evaluating evidence or models ….

Conclusions

Interaction Sequence 2

Students use various forms of rationale to justify the comment they are leaving in their talk, however when they leave the comment, they more generally ask probing / clarifying questions to nudge their peers to look for more evidence rather than handing it to them



Implications:

1. Gallery walks are a productive way to engage students in model critique and revision
2. Need to help students move from superficial noticing to evidence
3. Connecting via the interface helps students notice, but need more explicit practices to help with this sequence
4. Students connect evidence more consistently to a model when they see a clear conclusion from it, meaning complex evidence, or misleading conclusions are problematic
5. Helping students see a reason for refining their model using evidence (an object of activity) and linking that to the modeling criteria helps them engage deeply

Revisions

(tried in round 2, just completed):

1. Switch to entities, processes and outcomes (more intuitive for students)
2. Clearer criteria integration, and better establishment of shared criteria
3. Focus on developing "conclusions" from evidence to help make explicit links to the model
4. Simplify evidence until practices are developed
5. Narrative framing to focus on evidence as criteria
6. Highlight evidence as a criteria for good scientific models