Making Sense of a Warming Ocean: How STEM-related Talk and Gesture Combine to Support Students' Understanding of Climate Data

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Background

- Science learning in informal educational settings (e.g., fieldtrips) is inherently multimodal. Students use verbal (STEM talk) and non-verbal (gesture) resources to make meaning from complex phenomenon.
- Yet little is known about how students' gesture and talk work together during collaborative science activities to support science sensemaking in the moment (Rachmatullah et al., 2024).
- Although reflection is recognized as a key mechanism for consolidating learning (Pagano et al., 2019), few studies examine how students' multimodal engagement ***during*** science learning activities relates to their ***subsequent*** reflections.

Research Question

To what extent does students' in-the-moment STEM talk and gesture use ***during*** a map-based activity shape the quality of their ***subsequent*** science reflection discussions?

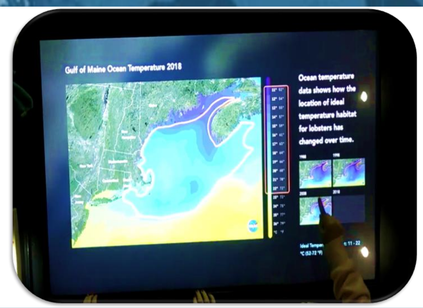
Participants

- 51 teams of two to four 5th and 6th grade students from 35 schools in Maine attended the LabVenture field trip at the Gulf of Maine Research Institute.
- 28 of the school groups were from coastal communities and 22 from interior communities.

Procedure

Sea Surface Temperature Maps Activity

- *ACTIVITY.* Students traced lobster's ideal habitat on thermal maps of the Gulf of Maine over four decades.
- *PROMPT.* Students were then asked whether the lobster habitat has changed over time.
- *REFLECTION.* Students recorded their 30-second final reflections addressing the prompt.



Gesture Coding		Proportion of Intervals
Beat	Rhythmic hand movements used to emphasize speech	3.77%
Deictic	Pointing or gesturing to the maps	72.94%
Conventional	Common gestures that may be used in place of language	1.83%
Imagistic	Gestures representing real objects, actions, sizes, or metaphorical concepts	12.26%

STEM Talk Coding		Activity *M* (SD)	Reflection *M* (SD)
Biology	Talking about biological processes (e.g., eating, dying), marine species (e.g., lobster, black sea bass), or marine habitats	1.11 (1.55)	.79 (1.10)
Data Analysis	Making data observations or referring to visualizations (e.g., table)	12.00 (7.04)	4.12 (3.35)
Geography	Referring to a specific location (e.g., Earth, Gulf of Maine)	.33 (.61)	.13 (.33)
Math	Mentioning quantities or mathematical formulas	1.29 (1.42)	.77 (1.39)
Metacognitive	Describing thought process.	2. 19 (1.74)	1.93 (1.67)
Spatial	Describing spatial locations, patterns, features, orientations, etc.	12.00 (7.99)	3.28 (3.11)
Climate	Words related to climate and factors contributing to climate change.	2.07 (1.79)	2.48 (2.59)

Results

- Gesture use during the activity was significantly associated with STEM talk during the activity (*B*=28.40, *p<.05*).
- Total STEM talk during the activity was significantly associated with STEM talk at reflection, (*B*=3.91, *p<.01*)
- Gesture use during the activity significantly predicted STEM talk at reflection.
- However, when STEM talk during the activity was added in the final step, gesture was no longer a significant unique predictor. This suggests that gesture's effect was not independent of STEM talk. Together, the predictors explained 21% of variance in STEM talk at reflection.

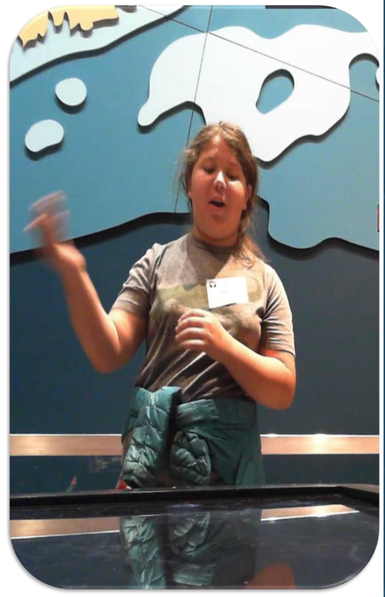
Table 1. Regression Predicting Students' STEM Talk at Reflection

Variables	B	95% CI B		SE B	β	R^2	ΔR^2
		LL	UL				
Step 1						.003	.003
Constant	18.51	12.72	24.31	2.87			
Activity Word Count	-0.01	-0.04	0.03	0.02	-0.05		
Step 2						.131	.129*
Constant	8.54	-1.34	18.47	4.91			
Activity Word Count	-0.01	-0.04	0.03	0.02	-0.05		
Proportion of Gesture at Activity	13.41	2.28	24.54	5.51	0.36*		
Step 3						.211	.080*
Constant	9.27	-0.35	18.89	4.76			
Activity Word Count	-0.03	-0.07	0.01	0.02	-0.32		
Proportion of Gesture at Activity	9.12	-2.43	20.73	5.74	0.24		
Total STEM Talk at Activity	0.15	0.00	0.31	0.08	0.41*		

Note. CI= confidence interval; LL= lower limit; UL= upper limit. *p<.05. **p<.01. ***p<.001.

Discussion

- Although the current design does not permit formal mediation analyses, the pattern of results are consistent with the possibility that gesture supports reflection through its association with STEM talk during the activity. Future work will explicitly test this pathway using mediational modeling.
- The work is consistent with embodied and sociocultural perspectives on learning which emphasize meaning making in informal settings is distributed across verbal and gestural resources (e.g., Alibali et al., 2014; Goldin-Medow & Alibali, 2013; Novack et al., 2014).
- These findings also carry practical implications for the design of field trips and informal learning experiences. Supporting students' multimodal, STEM focused talk during collaborative activities can deepen science sensemaking, as evident in their reflections.



Acknowledgements

This material is based on work supported by the U.S. National Science Foundation under grants 2115610 (LUC); 2115603 (GMRI); 2115905 (NU). Thank you to Amanda Dickes and the Gulf of Maine Research Institute as well David Uttal and the Northwestern team for their collaboration on this project. We especially thank all the families, teachers and students who participated in this project.