

From stomach dissections to STEM discussions: The power of annotation

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INTRODUCTION

- Informal learning experiences (e.g., field trips) can encourage understanding of a variety of STEM topics, including climate change (NRC, 2009).
- Annotation may be an especially important way of engaging with visual representations to support STEM learning (Ainsworth et al., 2011).
- In this study, we explored associations between middle school students' annotations made to visual representations during field trip activities and their STEM talk when reflecting on their learnings.

PARTICIPANTS

- 335 groups of three to six fifth- and sixth-grade students from 47 schools in Maine attended the LabVenture field trip at the Gulf of Maine Research Institute (GMRI)
 - 211 groups from coastal schools, 124 noncoastal schools
 - 221 mixed gender groups, 52 all girl groups, 62 all boy groups



Black Sea Bass (BSB) Program

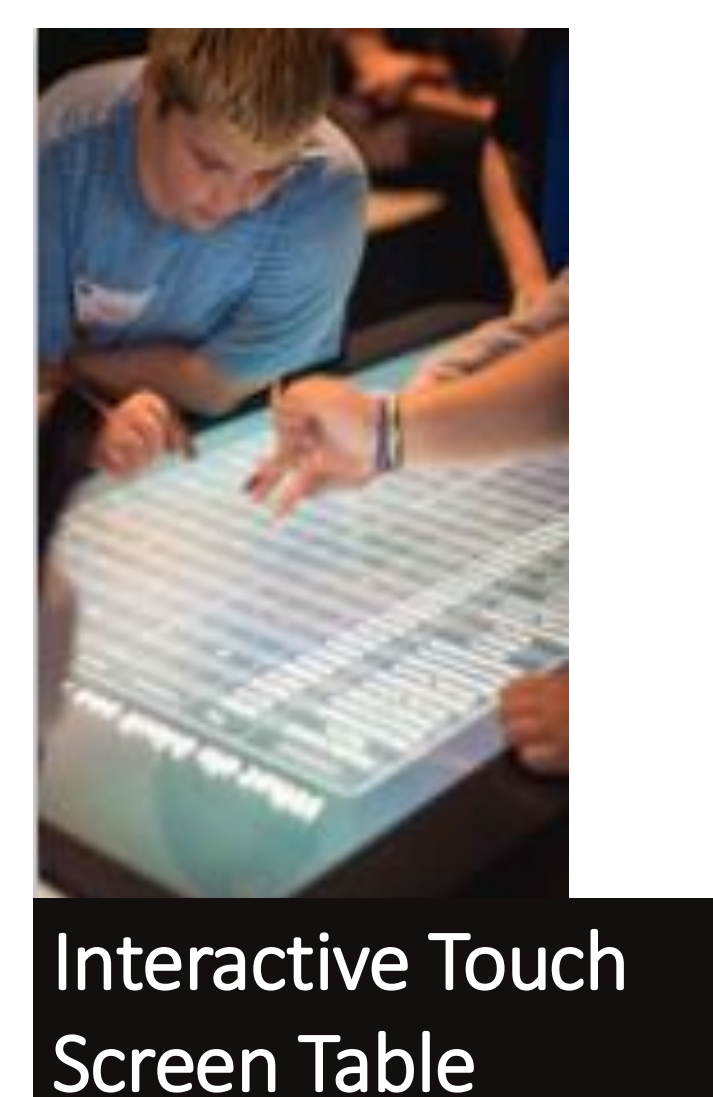
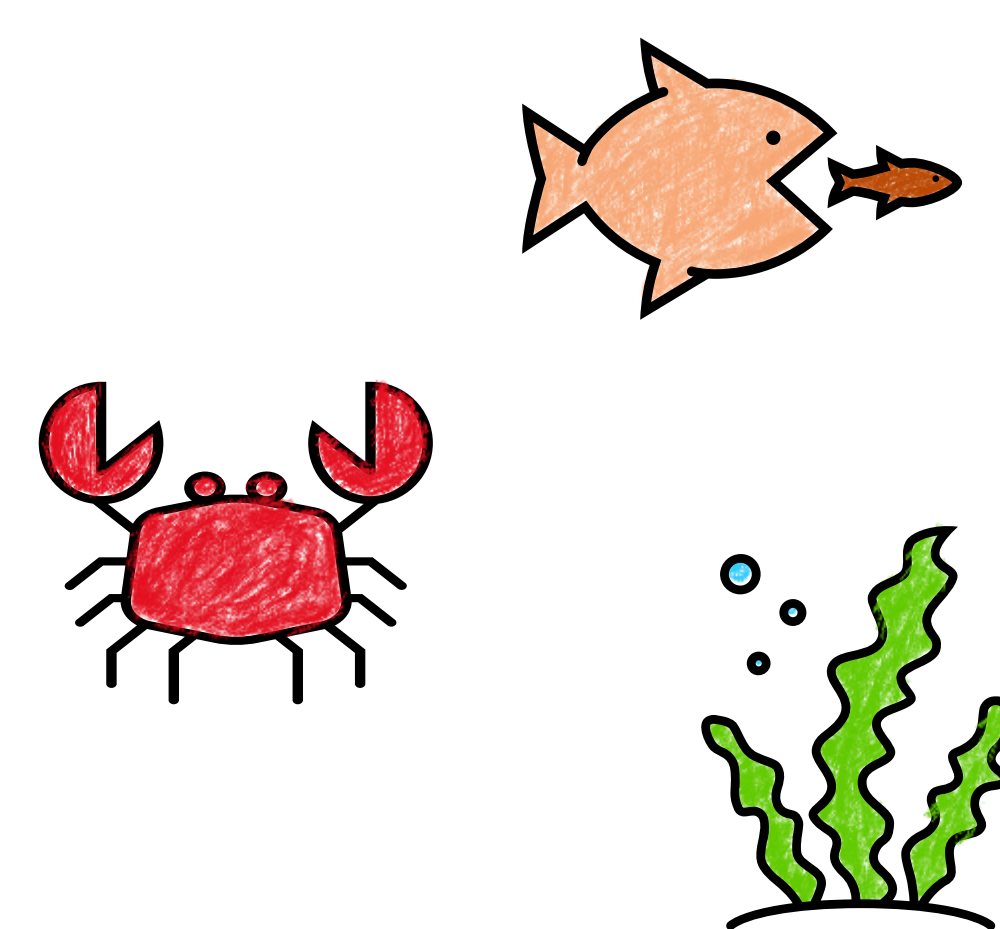
- 49.3% of groups annotated ($n = 165$); 50.7% did not ($n = 170$)
- Average of 2.98 types of STEM talk used in the reflections ($SD = 1.67$)

Sea Surface Temperature (SST) Program

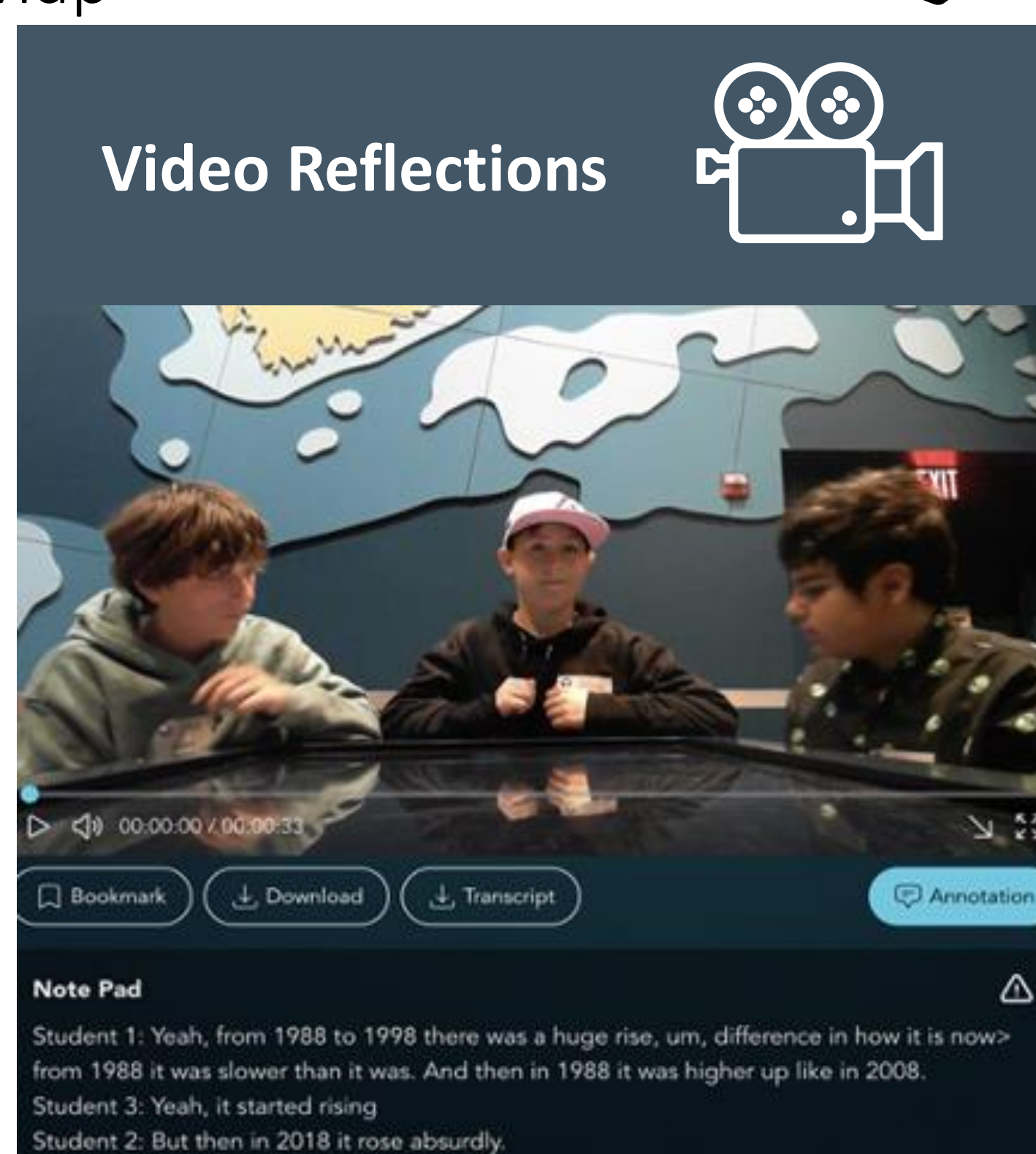
- 48.8% of groups annotated ($n = 163$); 51.2% did not ($n = 171$)
- Average of 4.26 types of STEM talk used in the reflections ($SD = 1.83$)

PROCEDURES

- Students engaged in 2.5 hours of various informal learning activities about climate change and marine life in the Gulf of Maine



- Students annotated visual data representations related to each activity
 - Black Sea Bass Stomach Dissection Table
 - Sea Surface Geothermal Temperature Map



- After each activity, students recorded a short video reflection about their learning.

CODING

Annotations

Codes	Definition
Writing	Using words or numbers
Drawing	Drawing images and symbols, shapes/Xs, or arrows
Lining	Highlighting, circling, underlining, or crossing out text

STEM Talk

Code	Definition
Biology	Talking about biological processes (e.g., eating, dying), marine species (e.g., lobster, black sea bass), or marine habitats (e.g., ocean, gulf)
Climate	Talking about climate or climate change (e.g., temperature, hotter)
Data Analysis	Making data observations (e.g., because, shift) or referring to visualizations (e.g., map, table)
Geography	Referring to a specific location (e.g., Earth, Gulf of Maine, United States)
Math	Mentioning quantities or mathematical formulas (e.g., five, many, multiply)
Metacognition	Describing thought processes
Spatial	Describing spatial locations, patterns, features, orientations, etc. (e.g., area, north, length)
Temporal	Referring to sequential, order, or time (e.g., before, third, year)

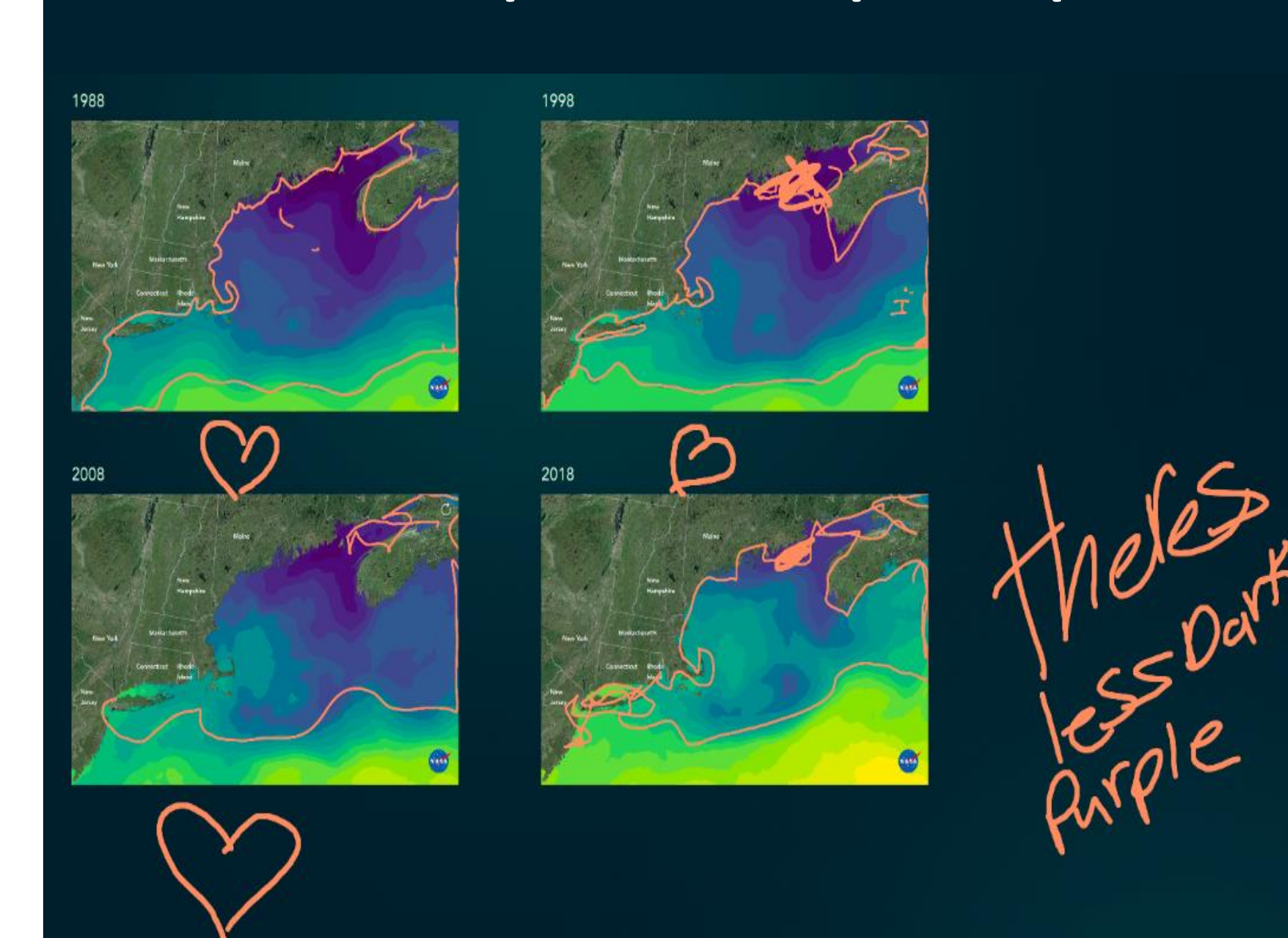
Black Sea Bass Dissection Table Example

Do you think lobstermen in Maine should be concerned about black sea bass appearing in the Gulf of Maine?

Tag	Location	Lobster	Fish	Squid	Crab	Starling
#0177	Maine					
#0225	Maine					
#0241	Maine					
#0213	Maine					
#0282	Maine					
#0207	Maine					
#0217	Maine					
#0211	Maine					
#0251	Maine					
#0255	Maine					
#0247	Maine					
#0222	Maine					
#0216	Massachusetts					
#0171	Massachusetts					
#0182	Massachusetts					
#0194	Massachusetts					
#0156	Massachusetts					
#0149	Massachusetts					
#0127	Massachusetts					
#0084	Massachusetts					
#0219	Massachusetts					
#0193	Massachusetts					
#0208	Massachusetts					
#0133	Massachusetts					
#0134	Massachusetts					
#0027	Rhode Island					
#0071	Rhode Island					
#0081	Rhode Island					
#0088	Rhode Island					
#0064	Rhode Island					
#0083	Rhode Island					
#0034	Rhode Island					
#0064	Rhode Island					
#0022	Rhode Island					
#0072	Rhode Island					

Not really

Sea Surface Temperature Map Example



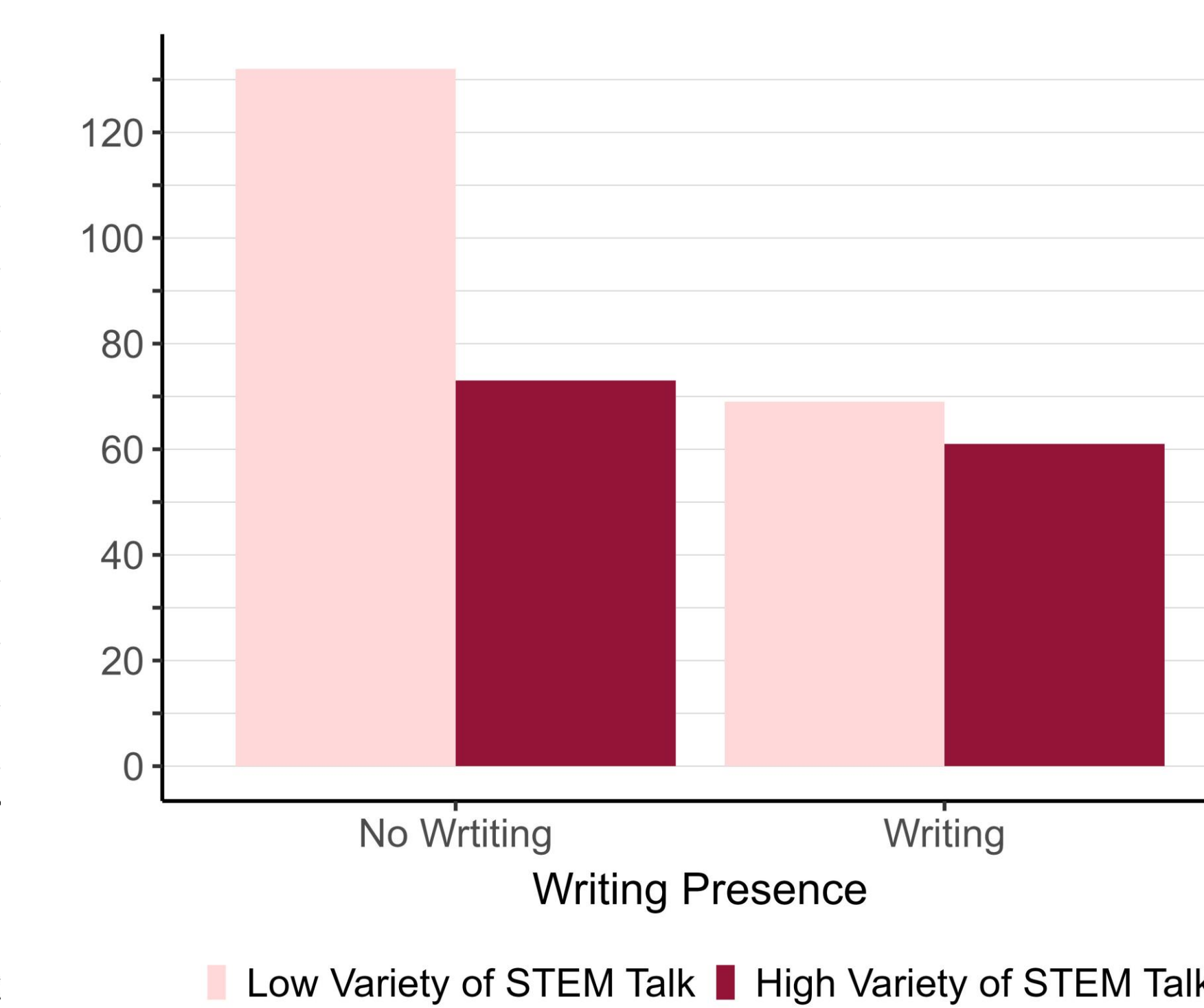
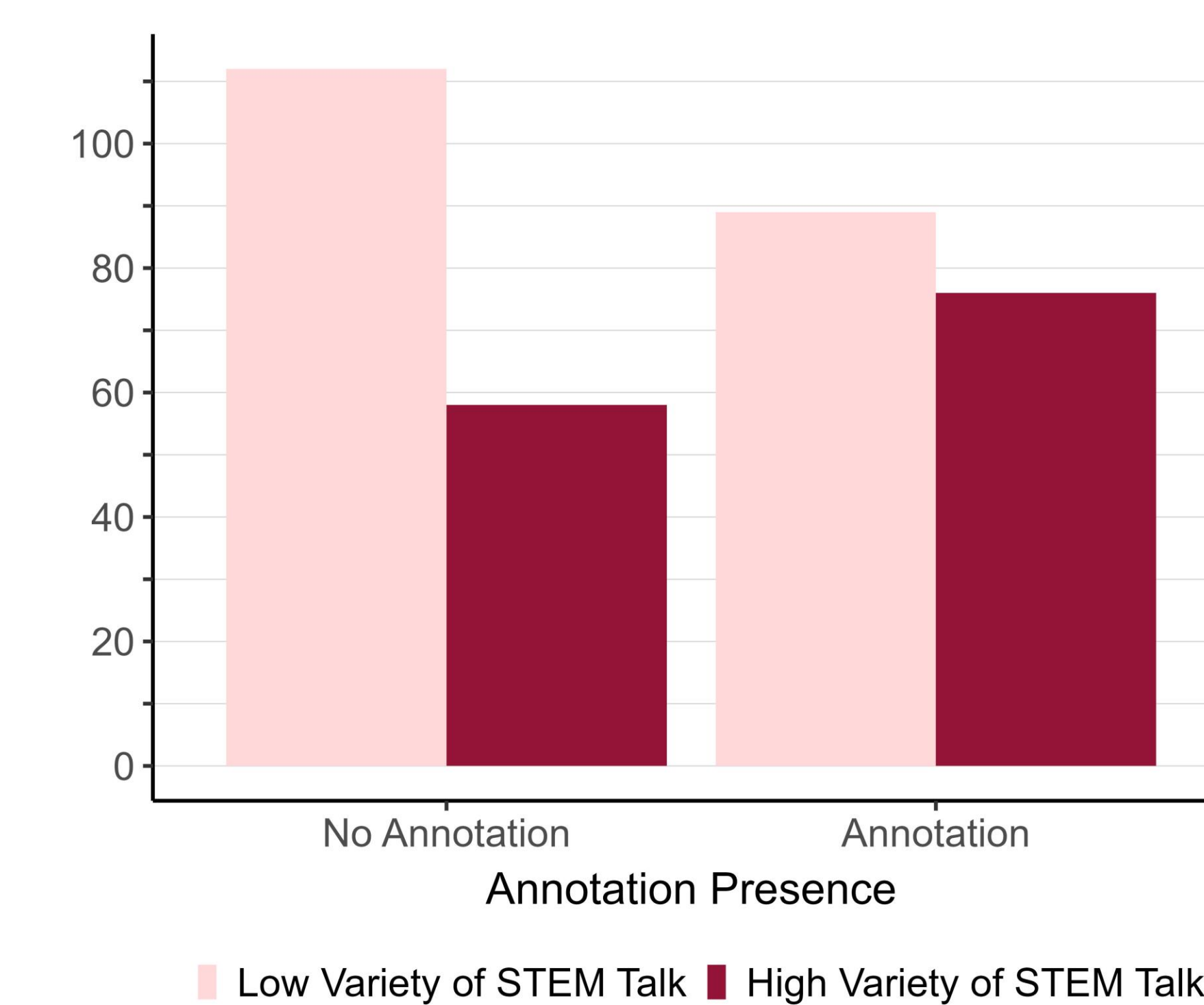
RESULTS

Black Sea Bass Stomach Dissection

- Students' number of annotation types positively correlated with the number of STEM talk types used in the reflection, $r(333) = .152, p = .005$.
- There is an association between the use of annotations and high/low variety of STEM talk, $\chi^2(1, N = 335) = 4.98, p = .03$ (Figure 1).
- A trend is approaching a significant association between writing on the table and high/low variety of STEM talk, $\chi^2(1, N = 334) = 3.04, p = .08$ (Figure 2)

Figure 1: Annotation and STEM Talk Variety

Figure 2: Writing and STEM Talk Variety

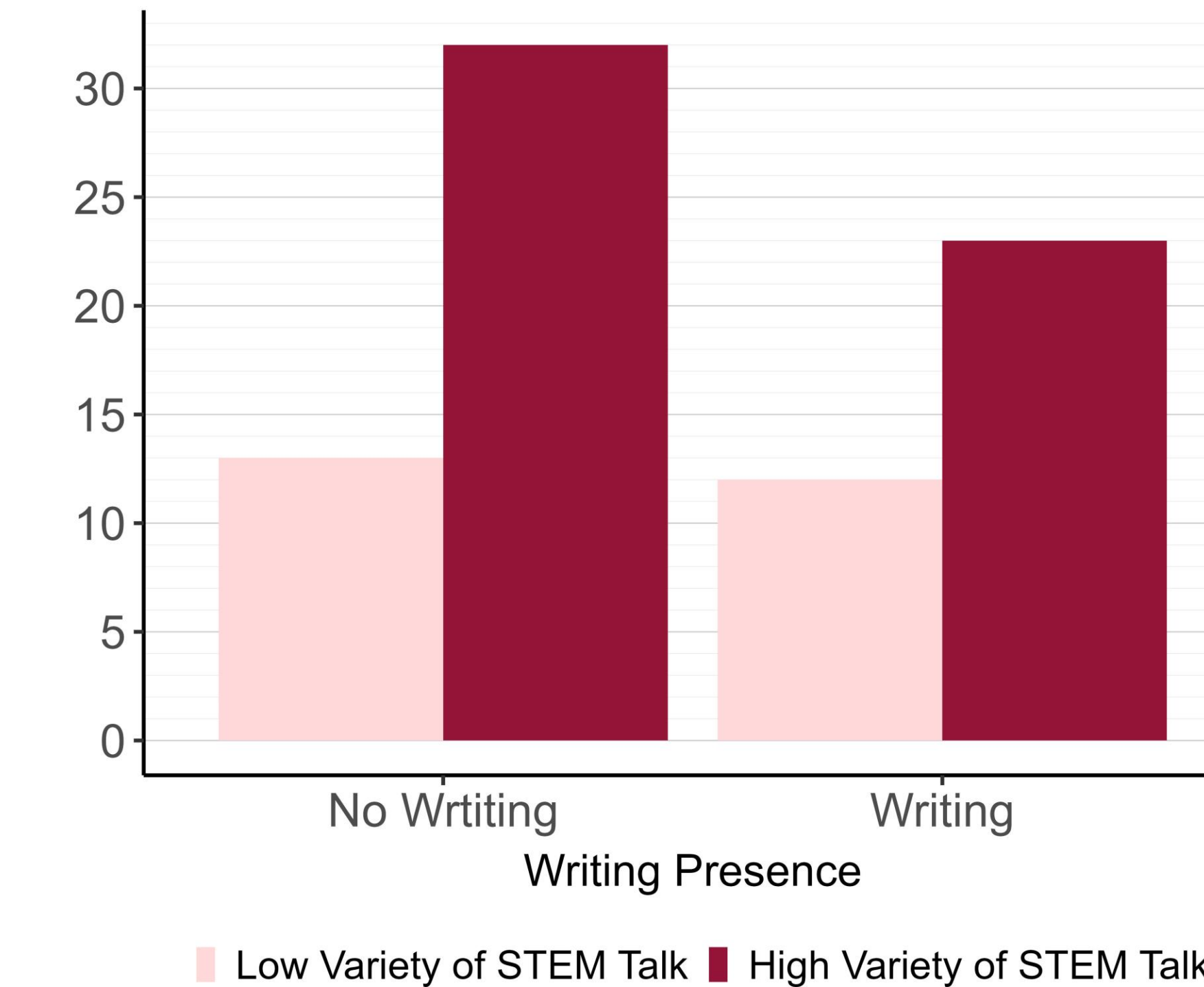
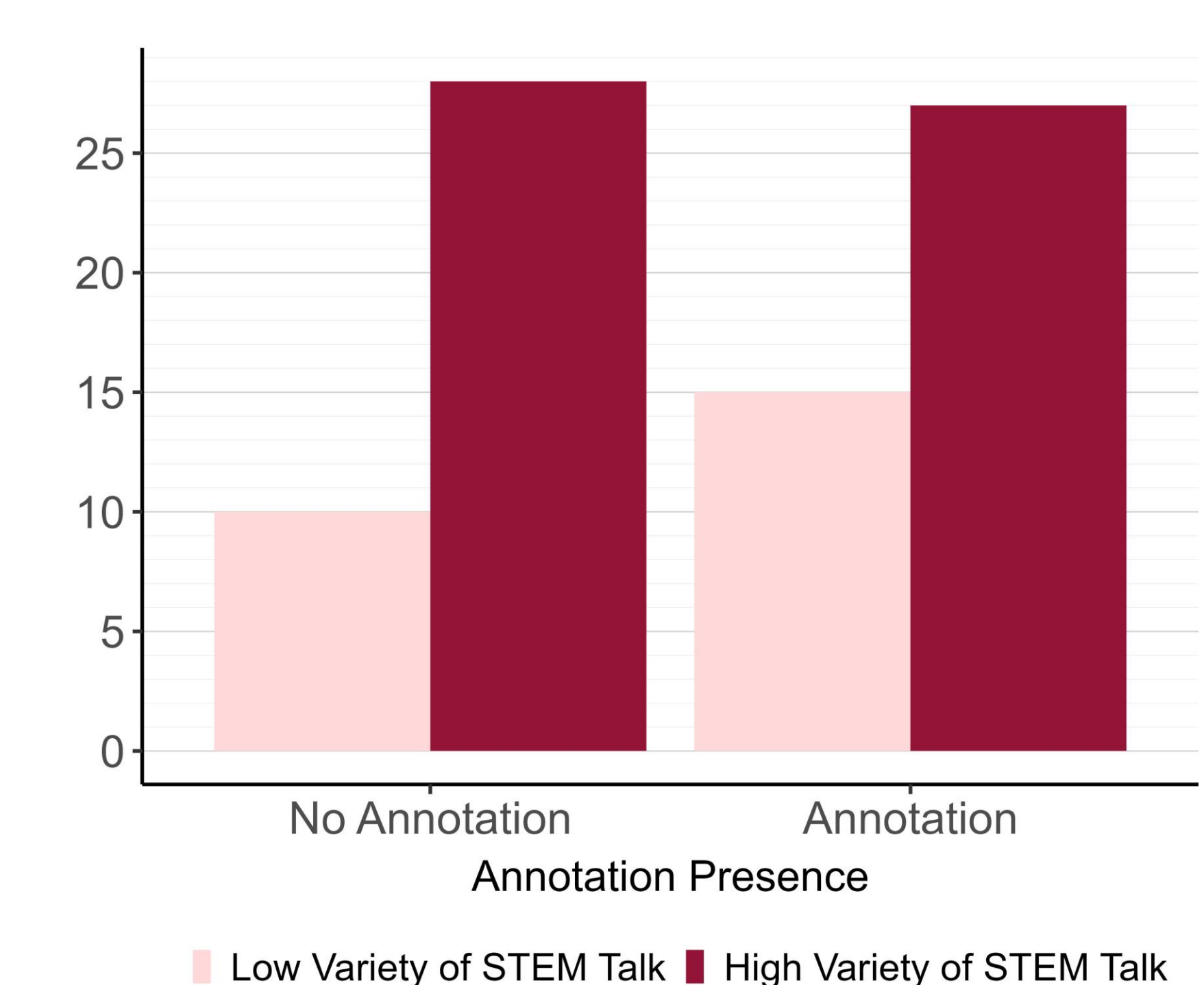


Sea Surface Temperature Mapping

- The number of annotation types made on the maps did **not** significantly correlate with the number of STEM talk types used in the reflection $r(78) = .010, p = .93$
- The use of annotations and high/low variety of STEM talk were not significantly associated, $\chi^2(1, N = 80) = .045, p = .83$ (Figure 3).
- Writing on the table and high/low variety of STEM talk were not significantly associated, $\chi^2(1, N = 80) = .001, p = .98$ (Figure 4)

Figure 3: Annotation and STEM Talk Variety

Figure 4: Writing and STEM Talk Variety



DISCUSSION

- Encouraging students to annotate visual representations appears to support engagement with a variety of scientific concepts, offering a tangible way for learners to interact more deeply with complex data.
- The impact of annotations may be highly dependent on the type of visual representation (e.g., maps vs tables).
- Annotation may be more relevant and effective in deepening specific types of engagement rather than broadening the scope of STEM discourse.