



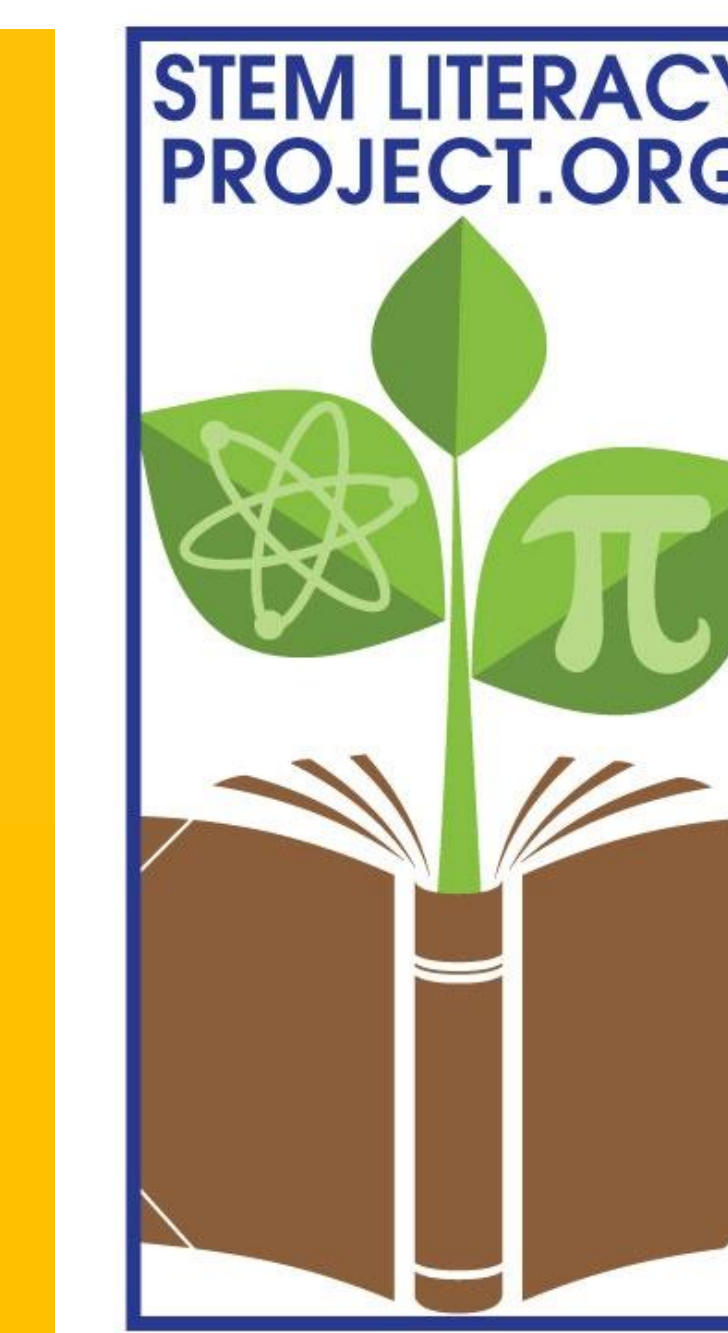
Measuring Issue-based Argumentation to Support Literacy Integration and Learning in STEM

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SBA CONSTRUCT VALIDITY

The seven competencies provide unidimensional (1st eigenvalue from PCA on residuals < 2) and reliable (r = 0.93) measures.

We observed 45.3% of the double-scored SBAs had exact agreements which matches well with the model-expected value of 47.8% exact agreements. This suggests model-expected consistency.

Mean squares fit indices indicate that: (1) the quantitative reasoning required skills peripheral to the central argumentation construct (infit = 1.91, outfit = 1.88). (2) the Vaping scenario contains bias which favors lower-ability students (infit = 1.55, outfit = 1.51) suggesting that students are led toward a particular response.

OVERALL GAINS IN THE COMPETENCIES BEFORE AND AFTER THE INSTRUCTION

The students attained an average gain of 0.89 logits (95% CI of 0.42-1.36 logits) which is statistically significant ($T_{df=250} = 3.68, p < 0.001$).

Three teachers made significant gains. T1 made the largest gains (Hedges G = 1.10, p < 0.01, N = 24) which were significant at the 2-tailed 99% confidence level. T2 (Hedges G = 0.26, p < 0.01, N = 33) and T3 (Hedges G = 0.52, p = 0.08, N = 20) facilitated moderate gains with their students which were significant at the 2-tailed 99% and 90% confidence levels, respectively.

INSTRUCTIONAL MOVES: These 3 teachers used various scaffolding strategies such as think-alouds, collaborative learning, multi-modal/visual text, intentional vocabulary instruction, and regular in-class informal journal writing to support learning. In interviews, students reported high engagement in these classrooms.

Participation in literacy-based science curricula improves students' ability to negotiate complex socio-scientific issues through written argumentation.

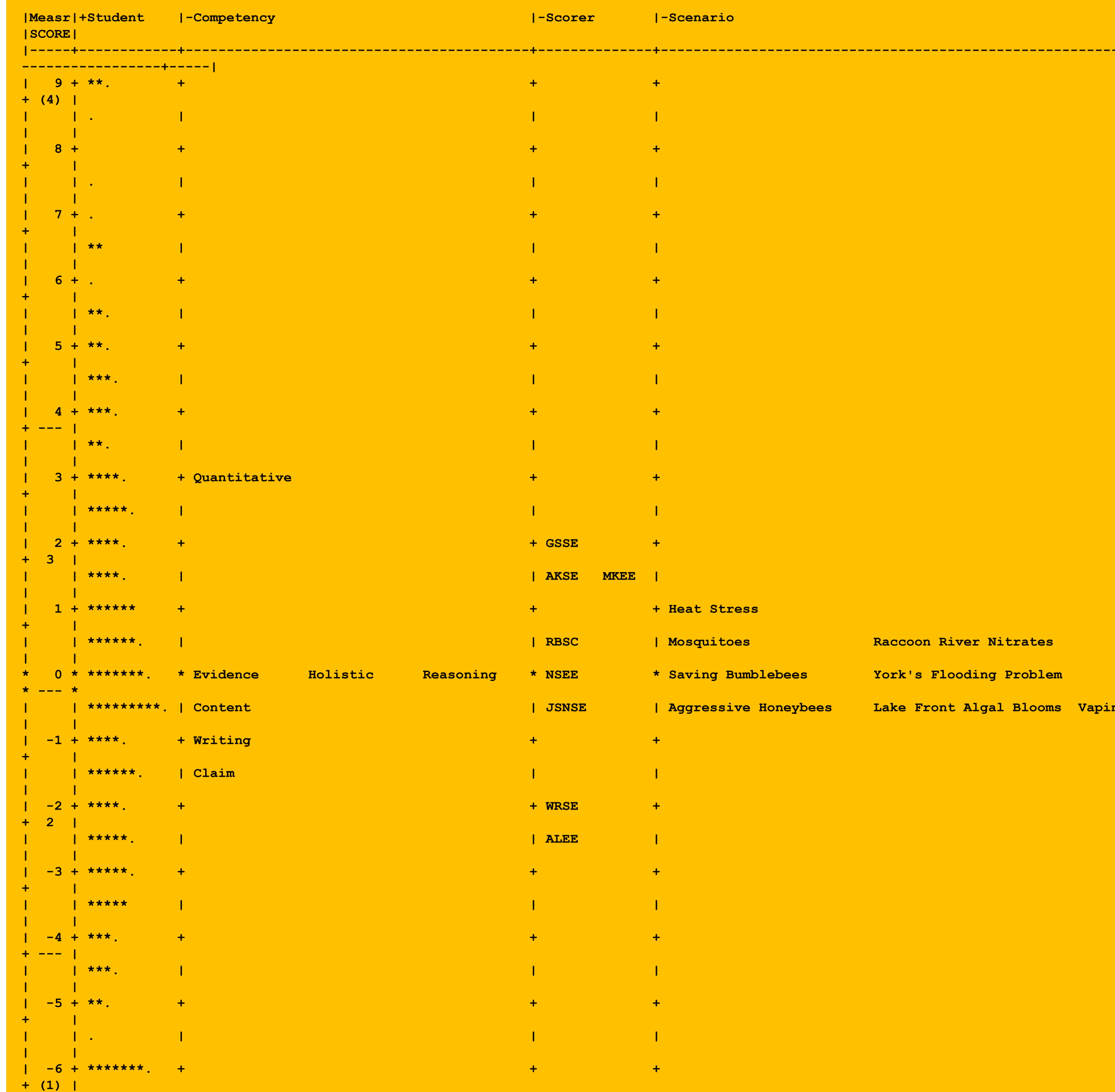


Figure 1: Map of the student, competency, scorer, and scenario facet measures on a linear log-odds scale.

Table 1. Effect size and significance of gains in the argumentation competencies.

Competency (N = 245)	Gain	Cohen's D	p-value*	95% CI
Claim	0.196	0.219	0.004	0.065-0.331
Evidence	0.224	0.237	0.001	0.094-0.359
Reasoning	0.200	0.214	0.005	0.065-0.335
Quant Reasoning	0.196	0.215	0.005	0.061-0.331
Content	0.171	0.187	0.009	0.041-0.302
Writing	0.212	0.227	0.001	0.082-0.343
Holistic Score	0.184	0.203	0.003	0.065-0.306

*2-tailed based on the percentile method with 10,000 bootstrap samples

LOW ABILITY RESPONSE

It's the rain and ground covering. Because on the charts over the years stuff goes up. And flooding goes up so that means that ground covering goes up because the flooding is moving something around.

HIGH ABILITY RESPONSE

The precipitation is not causing the flood. The measures of precipitation is and shows how much rain and how much snow cities receive each year. I don't agree with the person who said precipitation is causing all the flooding because of graph one showing how much precipitation. They said that the flooding had started in 2005. When you look at the graph back in 1936 there was about an average of 53 inches of precipitation. From 1936 the precipitation went down till 1981 and 1983 which both had the same amount of precipitation with 33 inches. From then the precipitation went up again but not by many years since it went back down during the year of 1995 with the precipitation being 31. I went back up through it went up till the year 2003 which was 35 in precipitation. 2 years past and it came to 2005 when flooding began the precipitation when from 47 in 2005 to 67 in 2013. I agree to it by being land. The change of the land started with 75 percent of natural land during 1973 but it went down as the years passed till 2013 with about 45 percent of land. The developed surfaces went up as people built the city. The water would have nowhere to go since the natural land isn't there much because of developed-impermeable surfaces being buildings and parking lots which is stopping the water. Developed-permeable would help the water a bit to escape since its opened areas like soccer fields covered with grass or city gardens.

PURPOSE

We present the development and use of scenario-based assessments (SBAs) to measure secondary students' ability to engage in written argumentation around socio-scientific issues (SSIs).

We explore construct validity of these assessments in terms of: (1) the efficacy of the competencies in providing a unidimensional measure of argumentation, (2) scorer consistency, and (3) transfer across multiple SSIs.

We use these assessments to evaluate gains in argumentation ability due to literacy-based science and mathematics instruction.

METHODS

Sample: 251 students across 12 teachers took both the pre-test given before instruction and the post-test given after instruction.

Each teacher chose one (of eight available—see Figure 1) SBAs to administer.

Nine independent experts participated in scoring. 10% of SBAs (n = 44 for the pre-test and n = 41 for the post-test) were double scored.

Responses were scored based on seven argumentation competencies (Table 1) using a 1-4 ordinal scale.

The average inter-rater consistency was 0.67 (Cronbach's alpha) based on the 10% of SBAs (n = 44 for the pre-test and n = 41 for the post-test) which were double scored.