Adolescent perceptions of purposes and risks of discourse impact middle school science learning

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Summary:
The United States lags behind most of the world’s developed countries (21st of 30 member countries) in scientific literacy (Alliance for Excellent Education, 2008). Because our economy relies so heavily on scientific innovation and the workforce is increasingly global, this lack of relative standing is of great concern. To help address this issue, researchers, teachers and policy makers are investigating the mechanisms leading to effective teaching and learning. Constructivist approaches to learning conceptualize thinking as discourse one has with oneself (Vygotsky, 1978). Further, discourse one has with others influences the way one engages in internal discourse. Therefore, how one perceives discourse could have an effect on learning. Here we explore the relationship among student’s scientific sensemaking, classroom science learning, and student’s perceptions of discursive argumentation to answer the following questions:

• How do adolescent’s perceptions of the purposes and risks of argumentation relate to scientific sensemaking?
• Do these effects influence classroom science learning?

Procedures:
702 (49% female, 33% white, 35% African American) students from 10 schools in 34 classrooms who were engaged in the Weather and Water Unit of The FOSS science curriculum were recruited into this study. Students were administered a knowledge pre-test and post-test (which acted as their unit test) as well as a scientific sensemaking measure and a measure of perceptions of argumentation.

Measures:
Sensemaking: We utilized a measure of sensemaking that focused on a topic of interest to middle school students (Bathgate, Schunn, & Correnti, under review)—how best to assist a population of pink dolphins who are threatened with extinction— and embedded enough information that even someone relatively unfamiliar with the topic had the opportunity to perform well. The measure captured a breadth of sensemaking skills culminating in a letter written to President Obama, who (the students were told) was set to attend a meeting focused on whether the dolphins’ natural habitat ought to be improved or whether the dolphins should be moved to a protected cove. The unidimensional sensemaking factor score consisted of nine forced choice items and four constructed response scores (see Nagy-Catz, et al, under review, for a complete description of the development and validation of this measure).
**Perceptions of the Purposes and Risks of Argumentation:** Students’ perception of the purposes and risks of argumentation were assessed with six questions contextualized in the same scenario as the scientific sensemaking assessment. Students were asked “You and your friend disagree about what should be done to help the dolphins. Would you talk to your friend about your ideas?” They were provided six responses drawn from work on young adolescents’ perceptions of the purposes (e.g., “because you could learn something from your friend that you didn’t know before,” “it’s important to share your opinion”) and risks (e.g., “it could hurt your friendship,” “it’s not nice to disagree with people”) of argumentation (Kuhn, Wang, & Li, 2011) and were asked to indicate the extent to which they agreed with each (choosing from completely agree, agree, disagree, and completely disagree).

**Classroom Science Learning:** The test was built from released TIMSS, NAEP, and state science test items that matched the overall content of the FOSS Weather and Water unit (Schunn, Richey & Alfieri, 2011). Only those items that matched the parts of the unit covered by all teachers were included in the final analysis (21 items).

**Results:**
ANCOVA models yielded a main effect of each purpose and risk of argumentation on student’s sensemaking: students endorsing the purposes of argumentation exhibited higher scientific sensemaking scores, as did students rejecting the risks of argumentation (i.e., reporting they would discuss their ideas with their friend despite the potential risks). Overall, students’ perceptions of the risks of argumentation had a greater effect on sensemaking than their perceptions of the purposes (see Table 1).

| Yes, because maybe you could learn something from your friend that you didn’t know before. | 4.61** | 0.03 |
| Yes, because maybe you could convince your friend to see things your way. | 2.95* | 0.02 |
| Yes, because it’s important to share your opinions. | 6.8** | 0.05 |
| No, because you can’t change another person’s opinion. | 14.98** | 0.1 |
| No, because it could hurt your friendship. | 14.73** | 0.09 |
| No, because it could hurt your friendship. | 27.48** | 0.17 |

* Significant at .05; ** Significant at .01.
Previous work indicated that sensemaking is a significant predictor of classroom science learning (Nagy-Catz, et al, under review). Here we have shown that one’s perceptions of argumentation are related to one’s sensemaking ability. Next we examine whether the perception with the largest effect (the notion that it is “not nice to disagree”) significantly moderates the relationship between sensemaking and classroom learning. A model was built predicting the final knowledge test score with the knowledge pre-test, sensemaking ability and one’s perception that it is or is not “nice” to disagree (that is, those who completely agree or agree were grouped together and those who completely disagree or disagree were grouped together). Included in the model is an interaction term between sensemaking and one’s perception of whether it is “nice” to disagree. ANCOVA reveals a main effect of pretest, sensemaking, perceptions of whether it is “nice to disagree” and a significant interaction between the perceptions of niceness and sensemaking (Figure 1). In essence, those who do not believe it is appropriate to disagree do not benefit from increased sensemaking abilities in terms of greater classroom science learning.

Moderation of sensemaking by whether one believes it is "Not nice to disagree" on classroom science learning
Discussion:

These results support the notion that valuing discourse (by means of endorsing the purposes or rejecting the risks) can have an impact on sensemaking abilities and classroom learning. Though this is correlational work and care must be taken in interpreting directionality, the take-away for educators is clear: supporting discourse in one’s classroom for all students (even those who have less sensemaking ability) could benefit learning outcomes. Downplaying or debunking the risks of argumentation in particular could have a particularly large impact.

