

A Comparison of Students' Conceptions about the Nature of Argumentation in School and Professional Science

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Abstract: This paper explores the relationship between students' conceptions about warranting claims in science class and their beliefs about how professional scientists warrant claims. An interview was used to measure beliefs about school science, and a questionnaire was used to measure beliefs about professional science. The difference of these expressed ideas in the two contexts have implications for understanding students' personal epistemologies of science as well as the coherence of students' epistemological beliefs.

Most students leave high school with overly simplistic ideas about the nature of scientific knowledge and how such knowledge is produced (Driver, Leach, Millar, & Scott, 1996). Research on epistemological beliefs in general has been criticized for conflating beliefs about the nature of knowledge with beliefs about how best to learn (Hofer & Pintrich, 1997), while research on students' beliefs about the nature of science (NOS) has been critiqued for making unwarranted assumptions about the coherence of presumed philosophical positions held by students. Recent research shows the inconsistency of students' epistemological ideas about science across varying contexts (Leach, Millar, Ryder, & Séré, 2000; Sandoval & Morrison, 2003). This raises the question of just what "science" students are thinking of when asked to consider the epistemological nature of science: professional science, the science that scientists do, or school science, the science that students do in school? In this study I will explore this question by narrowing in on one aspect of science, argumentation, and analyze students beliefs about argumentation in school science and how this relates to students beliefs about professional scientists argumentation. I chose the specific practice of *warranting claims* (justifying a scientific claim with evidence) during argumentation because this is one of the main ways scientific knowledge is created. Therefore, focusing a study on warranting scientific claims is really focusing on one of the foundations of science: warranting scientific claims to produce scientific knowledge.

Methods

Thirty-three students from one 7th grade science classroom participated in this study. The students in this study attend a public urban middle school located in a middle-income area of a large metropolitan city. All of the students participated in a plant inquiry module, *Sensing the Environment*, that was developed by UCLA's Center for Embedded Networked Sensing (CENS) as part of an ongoing effort to help science students engage in complex reasoning about real-world data. Students in this study used one network of sensors to pursue the ecological question, "Why do plants look different?"

Before students began the module they completed a 10 item open-ended questionnaire, Positions of Scientific Epistemology (POSE), to measure students' beliefs about the nature of professional science. This questionnaire is a version of Views of the Nature of Science (VNOS) developed by Lederman and his colleagues (2002), modified by the developers to simplify the language for middle school students. At the culmination of the module each student wrote an essay about why plants look different. To measure students' beliefs about their own warranting claims practices, students were interviewed about their essay. Interview questions focused on the claims students made in their essay and their warrants for these claims.

Data Analysis

To develop a fine-grained understanding of students' beliefs about warrant claims, as well as their beliefs about how professional scientists warrant claims, a categorizing analytic strategy was applied. With this strategy interview and POSE responses were categorized to determine the frequency with which students express various thematic ideas. Different themes and associated codes emerged from the interview data and POSE data. The one theme that emerged from the interview data was students' beliefs about warranting claims; four warrant types that emerged: authority based, data based, fact based, and causal based. Two themes emerged from POSE data these

were students beliefs about (1)how scientists know things (2)what scientists use evidence for (3)why scientists disagree.

Findings and Implications

Most students (64%) relied on data based warrants when they described the reason why they believed their claim. When students were asked to explain why they believed the claim they made they generally described the empirical evidence that they examined and explained how they interpreted it to supported their claim. The majority of the students' (77%) said that scientists know things because of some specific type of evidence, such as fossils or bones. Forty-nine percent of the students said that they thought scientists use evidence to prove something, find something out (24%), or get the right answer (12%). Students said they thought scientists disagreed because they have different opinions (28%), looked at different evidence (7%), lacked evidence (10%), one scientist was wrong (10%), or because scientists will never know the truth (8%). Thirty-three percent of the students could not provide an explanation for why scientists disagree.

Students were able to distinguish between the claims they made in their essay and the evidence used to support their claims. Students also recognized that they needed to interpret the evidence to make a claim. However, students expressed beliefs about how scientists warrant claims are very different then their expressed beliefs about how they warrant claims in school science. Students did not distinguish between scientists' claims and the evidence used to support their claims. None of the students mentioned anything about scientists interpreting their data; instead their expressed beliefs were about data being the final result. Most of the students were unable to provide a reason for why scientists disagree. Students may not have known why scientists disagree because possibly they do not think that scientists disagree since they do not think that evidence is interpreted. If a student thinks there is no room for interpreting evidence, and evidence is the proof, then why would scientists disagree?

The implications of these findings support the view that students do not have coherent epistemological frameworks across different contexts. Students are relying on a different set of beliefs about their own warranting claims practice, than their beliefs about scientists warranting claims practices. Mainly, students expressed beliefs on POSE are similar to what has been found in other studies (i.e., students have naïve ideas about scientists work) and their responses to the interview and their expressed beliefs during the Sensing the Environment activity show that students ideas about their own warranting claims practice are not naïve. Students express that in their own work a claim is different from evidence, and evidence needs to be interpreted to make a claim. However, students do not articulate the distinction between scientists' claims and evidence, and do not mention that scientists interpret evidence to make claims. More research needs to be conducted to understand how students' beliefs about warranting claims influence their practice of warranting claims. Since students have informed beliefs about their own warranting claims practice, how does this influence their efforts to warrant claims during inquiry?

References

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