Chapter 8
Quality Argumentation and Epistemic Criteria

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The language of science is not exclusively the enunciation of terms and concepts, facts and laws, principles and hypotheses. The language of science is closely related to the restructuring character of scientific claims about method, goals, and explanations, a character firmly established in the history, philosophy and sociology of science (Duschl, 1994; Duschl & Hamilton, 1997; Hodson, 1985). Language of science is a discourse that critically examines and evaluates the numerous and at times iterative transformations of evidence into explanations (Duschl & Grandy, 2007). Thus, as this edited volume on argumentation demonstrates, educational researchers are focusing on ways to understanding the language of science and to support dialogic argumentation in science classrooms.

Shifting the dominant focus of teaching from what we know (e.g., terms and concepts) to a foci that emphasizes how we know what we know and why we believe what we know (e.g., using criteria to evaluate claims) requires a different classroom culture and discourse environment. Consider for a moment what’s involved when science teaching and learning are formatted around argumentation practices. First, scientific knowledge claims include information about theory (what knowledge is important), method (what strategies for obtaining and analyzing data are appropriate), and goals (what outcomes are sought and how can we determine if the outcome has been attained). A curriculum, instruction, and assessment design challenge is providing teachers and students with tools that help them build on nascent forms of argumentation to develop more sophisticated and rational scientific knowledge claims. Equally important, as Siegel (1995) argues, is the need to address the development of criteria students employ to determine the “goodness”, the normative status, or epistemic forcefulness of reasons for belief, judgment and action.

Engagement in argumentation discourse also requires appropriation of criteria and of evidence for the evaluation of arguments (Kuhn, 1993). Driver et al., (1996), White and Fredericksen (1998) and Duschl (2000) each point to the importance of students seeing scientific inquiry as epistemological and social processes in which knowledge claims can be shaped, modified, restructured, and at times, abandoned. Thus, learners need to have opportunities to discuss, evaluate, and debate the processes, contexts, and products of inquiry. Such discussions and debates expose the members of the community to each others’ ideas, opinions, sources of evidence,
and reasoning. These discourse processes also make thinking visible to participants. Such visibility can, in turn, provide a powerful mediation or formative assessment opportunity. Herein lies the importance of locating robust argumentation frameworks that will provide the appropriate level of details for guiding the development of students’ argumentation practices. The feedback on thinking can come from the students themselves as well as the teacher. But it is the teacher that sets the agenda for mediating the learning environment that can support formative assessments on pupils’ scientific thinking and reasoning. The challenge of teaching higher level thinking for teachers is fundamentally one of managing the ideas and information that are generated by students (see Zohar, this book).

The adoption and development of argumentation frameworks has gained in importance over the last two decades as researchers and curriculum developers seek ways to either nurture dialogic discourse in classrooms or to analyze the development of students’ reasoning with evidence and theory. When looking across the various available options for argumentation frameworks one sees that there are issues regarding the “grain size” of information being sought and used (Sampson & Clark, 2006; Duschl & Osborne, 2002). Toulmin (1958), for example, distinguished between field-dependent and field-independent forms of argumentation with the latter focusing on the general patterns of arguments involving claims, warrants, backings, rebuttals, qualifiers and conclusions. The question asked by Sampson and Clark (2006) in a review of 5 different frameworks for examining rhetorical argumentation is “How does any framework inform us about the quality of students’ argumentation?” This is an important question and one that is taken up in this chapter. Specifically, argumentation while common among many cultures and communities, when played out in science argumentation discourse has particular rules for “what counts” for knowledge building. Such knowledge building rules represent the epistemic demands (Sampson & Clark, 2006), epistemic resources (Hammer & Elby, 2003), epistemic actions (Pontecorvo & Girardet, 1993) and the practices of epistemic communities (Duschl & Grandy, 2007). Thus, as stated above, when thinking about argumentation discourse in classrooms, there is a need to have tools that can support or scaffold students’ participation in argumentation discourse and, importantly, teachers’ assessment of the students’ argumentation.

Sampson and Clark (2006) review 5 frameworks used for the assessment of argument:

- Toulmin’s Argument Pattern in science education research (Erduran et al., 2004; Jiménez-Aleixandre et al., 2000; Kelly et al., 1998);
- Zohar and Nemet’s modification of Toulmin (Zohar & Nemet, 2002);
- Kelly and Takao’s framework examining the epistemic status of propositions (Kelly & Takao, 2002; Takao & Kelly, 2003);
- Sandoval’s framework for examining the conceptual and epistemic quality of arguments (Sandoval, 2003; Sandoval & Millwood, 2005); and
- Lawson’s framework for examining the hypothetic-deductive validity of arguments (Lawson, 2003).