

Introduction to special issue: Epistemic tools in science education

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Abstract

We argue that unless teachers provide students with openings to take up some form of epistemic agency through the use of tools, and if students do not perceive and act on such openings, then the rhetoric of the Framework and Next Generation Science Standards—focused on participation in practices—is empty and aims to perpetuate the status quo of current and problematic science teaching and learning. Drawing on our own work and that of others, including the authors in this special issue of *Science Education*, we assert that epistemic tools and their principled use in classrooms have an important role in disrupting the status quo.

KEYWORDS

classroom, epistemology, tool

1 | INTRODUCTION

In this era of standards-based reform, documents such as the Next Generation Science Standards (NGSS) and the Framework for K-12 science education (National Research Council, 2012) continue to challenge us in terms of new expectations for teaching and learning. As a consequence, supporting science educators, teacher educators, teachers, and students as they work through complex, unfamiliar shifts in teaching and learning remains paramount.

Such shifts are not limited to intellectual responsibilities and roles. Social aspects of classrooms also require new strategies, tools, and approaches, on the part of both students and teachers. One such foundational shift is for teachers to provide students with opportunities to assume greater responsibility for their own knowledge building and to participate in the knowledge building of their classroom community. As Miller, Manz, Russ, Stroupe, and Berland (2018) propose, students' recognition of such opportunities, and their subsequent actions to shape knowledge production and practices, is a feature of an epistemic agency.

We argue that unless teachers provide students with openings to take up some form of epistemic agency through the use of tools, and if students do not perceive and act on such openings, then the rhetoric of the Framework and NGSS—focused on participation in practices—is empty and aims to perpetuate the status

quo of inequitable science teaching and learning. Drawing on our own work and that of others, including the authors in this special issue of *Science Education*, we assert that epistemic tools and their principled use in classrooms have an important role in disrupting the status quo.

2 | THE MAIN CHALLENGE: DISRUPTING EPISTEMIC INJUSTICE THROUGH EPISTEMIC TOOLS

Students' recognition and use of epistemic agency aim to disrupt a common occurrence in classrooms—the denial of knowledge production opportunities to certain individuals and communities, and the silencing of their voices by marginalizing them from public discussion. Fricker (2009) calls such marginalization “epistemic injustice”, asserting that such injustice can result in the loss of intellectual courage, the belief that one's ideas are important, and the hope that one's voice is heard and valued by people with power.

Our particular interest in epistemic injustice as a central component of this special issue of *Science Education* emerged from our collective research and inquiry about epistemic tools in learning settings. Broadly, epistemic tools encompass varying strategies or resources to purposefully motivate and facilitate individual and group knowledge production made possible through productive discourse, reasoning strategies, making thinking visible and available, understanding of nature, and use of evidence and sensemaking driven by student questions. All of these elements (situated interactional accomplishments) are foundational to the enactment of science and engineering practices.

Our definition of epistemic tools emerged from a robust body of research that has accrued over the last 20 years on how students learn (National Academies of Sciences, Engineering, & Medicine, 2018; National Research Council, 2000; National Research Council, 2005; Windschitl, Thompson, & Braaten, 2018), as well as earlier work in sociocultural studies on cultural tools and their role human learning (Vygotsky, 1980; Wertsch, 1988). We situate epistemic tools at the intersection of four mutually reinforcing strands of work: (a) the role of both cognition and social experiences in how students learn; (b) attention to learning as a process situated in social, cultural, and physical contexts; (c) the critical role of community in advancing agentive students who experience collaborative, distributed sensemaking with classmates as a common occurrence; and (d) the importance of a community in providing opportunities for learning and participation rather than putting the onus on individuals for engaging in action that they do not understand, and, as a result, are often positioned as incapable of doing. We propose that a primary goal of epistemic tools is to disrupt historic norms for participation in classrooms and to provide support for teachers and students in building a classroom culture that cultivates epistemic justice.

To begin a conversation about the role of epistemic tools in disrupting epistemic injustice in classrooms, we present this special issue, which brings together diverse perspectives authored by differently positioned contributors, including collaborative pieces offering innovative approaches. Selected articles illustrate that high-quality epistemic tools exist, and have multiple applications, including supporting classroom routines, science and engineering practices, productive student discourse, collaborative sensemaking of science ideas, and artifacts and technology to support students in representing their thinking. The scholarship in this issue focuses on diverse epistemic tools ranging from representational gestures by students to new technologies for supporting student investigations of phenomena, and strategies for making thinking public and available to all.

This special issue makes an important contribution to the field in presenting a series of peer-reviewed articles that demonstrate the theorized use of epistemic tools in classrooms—their affordances and challenges. As a field we are learning about these affordances and challenges and this issue will add to this growing fund of knowledge.

3 | QUESTIONS FOR THE READER TO CONSIDER ACROSS PAPERS

As the articles illustrate, disrupting epistemic injustice, and promoting epistemic agency requires much more public, principled, and adaptive forms of pedagogy than in the past. We propose that epistemic tools have an important role to play in advancing these pedagogical shifts and in creating the conditions for equitable participation and knowledge building in classrooms. However, many questions remain about epistemic tools in relation to epistemic agency and the future of science teaching and learning. Here are some questions of interest to us and perhaps to others reading this special issue:

- How can we as a community of teachers, researchers, and policymakers develop a useful consensus and shared language around “epistemic tools,” while also allowing for divergence—different perspectives, positionalities, contexts, cross-talk, and innovation?
- What critical questions need to be asked to further the field's knowledge about epistemic tools as disruptors of nonproductive rituals, routines, and practices in science teaching and learning?
- What might be helpful areas of debate or disagreement around epistemic tools? What are high-leverage “hinge ideas” to interrogate collectively?
- What is being learned about epistemic tool use in the classroom among students who have been historically and purposefully marginalized in science classrooms?
- What elements of the Next Generation Science Standards (NGSS Lead States, 2013) and the NRC *Framework for K-12 Science Education* can and should be leveraged in the development of and research on epistemic tools?
- What are the implications of this work on epistemic tools—in classrooms—for teacher professional learning, exploring PD, and teacher education as sites of progressive knowledge building, agency, and equity?

We encourage you, as a reader, to consider these and other questions and ideas you have about epistemic tools. Our list of questions is not exhaustive, nor is it exclusive to any discipline or genre of research. Our hope is that these questions might serve as a partial lens through which to read and consider the featured articles in this special issue. In addition, these questions might spur future research, critical conversations, and necessary conceptual and practical work among researchers, teachers, and students.

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