High school students' epistemic engagement in producing documentaries about public science concerns

David J. DeLiema, Jarod M. Kawasaki, William A. Sandoval, U. of California at Los Angeles, 2024 Moore Hall, Box 951521, Los Angeles, CA 90095-1521 USA
email ddeliema@gmail.com, jarodkawasaki@gmail.com, sandoval@gseis.ucla.edu

Abstract: Recently, situated theories of cognition and learning have attracted personal epistemology researchers, motivating efforts to revise traditional PE theories of developmental stages and independent beliefs. In the situated framework, researchers view knowledge practices as tentative and dependent on particular contexts. In the present study, we qualitatively examine the epistemic aims (i.e. defending a personal conviction about a knowledge claim) and the epistemic actions (i.e. questioning empirical data) that high school students bring to bear in multiple contexts within a classroom where each student creates a documentary film about a public science topic. We describe several socially-situated variables that drive the formulation of epistemic aims and the consequent selection of epistemic actions: dimensions of interpersonal relationships compatible or conflicting with epistemic goals, constraints that arise from completing classroom tasks, and personal affiliations with target topics.

Introduction

Pedagogical interest in epistemic cognition stems in part from empirical evidence suggesting the beliefs students have about knowledge influence the way they learn. For example, students who consider physics to be complex might investigate the complex interactions between variables in physics problems, whereas students who view physics knowledge as simple might memorize formulas (Hammer, Elby, Scherr, & Redish, 2005). We refer to the ideas students have about knowledge as epistemic beliefs (e.g. Schommer, 1990) and the actual knowledge practices they deploy in classroom exercises as epistemic cognition (e.g. Chinn, Buckland, & Samarapungavan, 2011).The promise of correlating beliefs about knowledge with practices around knowledge rests on a core empirical question: Do students' beliefs and practices around a knowledge domain *persist across contexts* within a classroom, and if not, what *dimensions of context* motivate different expressions of epistemic cognition?

We examine the construct of personal epistemology through a situated framework to throw light on the context question. Recently, situated theories of cognition and learning have attracted personal epistemology (PE) researchers, motivating efforts to revise traditional PE developmental stages theories (Perry, 1970) and independent beliefs systems models (Schommer, 1990). The traditional developmental and belief systems frameworks hypothesize that students have robust ideas about knowledge that are stable and correspond to (or surface as) self-assessed beliefs phrased in words during interviews or on surveys outside classroom situations. These professed beliefs are tacitly assumed to transfer into enacted practices around knowledge in classroom activities. Some studies, however, have found that variation in context—whether across questionnaires, enacted curriculum, or reasoning on science problems—leads to differences in epistemic cognition for the same participants (see Sandoval, 2005).

In the situated framework, researchers view knowledge practices as dependent on particular contexts. As such, we examine not only students' beliefs about the nature of knowledge and knowing, but also how epistemic cognition varies situationally, what Bromme (2000) alluded to in question form as, "why and with what aim epistemological beliefs emerge and for what are they needed?" (p. 199). The epistemological resources framework (Hammer & Elby, 2002) in fact preceded Bromme's call and launched the situated PE approach, positing that epistemic cognition involves fine-grained cognitive resources such as *accumulation, formation, checking* that frame actions. Even though the framework spells out a variety of knowledge resources (although openly incomplete) students may activate, the framework remains silent on the contextual variables that matter for their activation. In providing a partial answer to the context lacuna, Chinn et al. (2011) have formulated an ambitious theory that offers some structure to the construct of context as it involves epistemology. Standard PE models consider two epistemic dimensions: the nature of knowledge, including its source and form, and the nature of knowing processes, including ideas about certainty and justification (Hofer & Pintrich, 1997). Chinn and colleagues expand this model to include a variety of other aspects of epistemology, most importantly for our purposes here, the new dimension of epistemic aims. Epistemic aims—such as gaining knowledge, understanding, or having true belief—are the goals that motivate knowledge practices. Chinn et al. argue that if we fail to model students' epistemic aims, then we remain essentially blind to whether students will actually deploy a set of epistemic practices in a particular situation.

This paper answers Bromme's (2005) call by adopting a mixed version of the epistemological resources model (□ammer & □lby, 2002) and Chinn et al.'s (2011) recent framework to account for how social dimensions of activities present constraints and affordances on epistemic aims and resources. The activity system of interest in this study takes place in a high school summer course focused on students creating documentary movies around public science issues. We hypothesize that within this activity system, students' epistemic aims arise out of interactions between the goals they are pursuing (namely those resulting from personal affiliations with a topic), features of the task structure (namely time constraints), and social relationships (including, centrally, power relationships). We expected that having students manage a long-term documentary project where they had to find and evaluate diverse source materials, including claims from news reports, family, and friends, would involve some of students' everyday experiences with science and generate a variety of constraints on epistemic aims. We created a learning space where public and familial experiences were integrated with classroom activities in order to get a glimpse of how foregrounded social context impacts epistemic cognition.

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The study took place during a five-week high school summer course on scientific media literacy and documentary movie making at a local state university. The class met for two and a half hours, five days a week for five weeks. There were □9 students enrolled in the course, of which □□ consented to participate (□□□□, 2 girls, □□-□□ years old) and seven (□ girl) focused on public science topics. All the participants have been given pseudonyms in the analysis section. □articipants came from various ethnic and socioeconomic backgrounds and attended various high schools, both private and public. □n a blend of design-based and action research, the second author taught the course and maintained a daily reflective journal while the lead author observed the class four times, recording field notes about specific interactions for three students. Through an iterative process accounting for class experiences and curriculum design, we designed activities around the elements and structure of television news narratives, highlighting rhetorical (e.g. representation, persuasion, power, relevance) and narrative (e.g. perspective□camera angles, symbolism, empathic anchors, verbal-visual-discontinuities) elements. Students engaged with these elements around a self-selected science topic covered in the media, evaluating various sources of information on their topic, including experts in the media, local experts, peers, and family, critiquing popular news media, and creating a documentary film. Students documented their class experiences through online journal entries, responding to the day's lesson and additional reflection questions. The primary student artifact was a documentary film about their selected science topic, examined through multiple sources such as the news media, personal interviews with family and friends, a reflective video journal, and selected video clips from the internet, to be shared in a public □&A screening with over □00 peers enrolled in other classes at the school. Students also maintained a daily media consumption log, where they reflected on various media sources they encountered.

□nour analysis, we focused on multiple events in the classroom that suggest factors relevant to students' epistemic aims and resources. Specifically, we tracked the experiences of three students observed in detail in our field notes, and through a grounded approach, iteratively examined all data sources for those students and identified salient themes that emerged. The first and second authors independently coded written artifacts and student documentaries along the dimensions of epistemic aims, epistemic resources, and social□task constraints. We adopted an approach of writing memos and building conceptual flow charts as a way to develop the conceptual categories in a constant back and forth with the data. Through our analysis, we have identified exemplary events that demonstrate how potential contextual factors motivated different epistemic aims and resources.

For data, we triangulate between students' verbal discourse, nonverbal behaviors, and constructed artifacts to model the epistemic resources recruited in specific settings and to infer the epistemic aim(s) adopted. □nso doing, we take into account the full activity system—tools, rules, divisions of labor, and communities (Cole & □ngestr□m, □99□)—to begin to explore how social dimensions of the setting drive certain epistemic aims. Methodologically, we deviate from Hammer & Elby's (2002) definition of epistemic resources by focusing only on the observable epistemic *actions* students take rather than accounting also for the cognitive resources that frame those actions. As such, we use the term epistemic action for the remainer of the paper. □n summary, we describe the context that forms around epistemic cognition along three dimensions□(1) students' *observable knowledge practices* such as checking a document or asking a question (epistemic actions), (2) what we can *infer about students' knowledge aims* such as attempting to cast doubt on a claim or qualify a claim (epistemic aims), and (□) *situational factors* that impact the former dimensions. The third dimension identifies non-epistemic variables in the activity system that may have motivated the epistemic aims adopted and the resources deployed.

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We found that students' practices around knowledge in classroom activities varied as a function of multiple factors. Namely, social interactions between the student and the teacher, researcher, family, peers, and the public, in addition to constraints in the medium/activity engaging the student and goals springing from personal affiliations with the topic, seemed to frame epistemic aims and actions. We organize our findings along four different interaction spaces: (1) student and task, (2) student and other authority figures, (3) student and teacher, and (4) student and peers. Vignettes and student artifacts are used to demonstrate how features of settings motivate epistemic aims and actions.

Student and task

First, we examine the interaction between the student and the dominant task in one instance that exemplifies how the full activity system constrains the formation of epistemic aims. While the course attempted to encourage students to independently pursue a chosen topic, the teacher confirmed that students were under conventional constraints, such as needing to complete activities on time. On many occasions, a student named Saahil expresses that he is uncertain of whether global warming is true. A few days before his final project presentation, Saahil is working in a classroom adjacent to his usual room (due to space constraints) when the teacher from the other class overhears Saahil talking about his uncertainty. The teacher introduces himself as an expert on global warming (with a college degree in environmental science) and the following interaction occurs (as described in the researcher's field notes):

> "You could put lots of things," the teacher explains, including how CO_2 warms the atmosphere, CO_2 dissolves and turns the oceans more acidic, and how ice melts. Saahil perks up: "I'm doing ice melt!" The teacher responds, "Are you trying to prove or disprove?" Saahil: "Giving both sides." The teacher again, "It's so complicated, you might want to narrow down your focus." As the teacher walks away, I ask Saahil how much of the discussion made sense. Saahil says, "Some of it." Five minutes later, the teacher projects on the white board a list of about ten specific questions Saahil could address. The teacher happily offers his help. Saahil gives the teacher a silent nod and looks back at his computer. (12/22/11)

We might suppose that with the list of questions and the offering of expert help, Saahil would pursue an aim to evaluate the questions he had been mulling over all summer, narrow his focus, and take up a more concrete position. After all, in conversations with the researcher, Saahil states that opinions on global warming could change, and on the Schommer Epistemological Questionnaire, he provides multiple answers suggesting that he is "very" certain that scientists can find truthful answers to almost anything if they try hard enough. But at this point in the activity, Saahil has two days remaining to work on a documentary that is still two minutes short. Saahil, in his role as *student needing to finish the assignment on time,* prioritizes getting the film to 5 minutes (the assigned length repeatedly enforced by the teacher in whole class discourse), which Saahil manages with a documentary exactly 5 minutes and 1 second in length. The final documentary does not incorporate any of the feedback from the neighboring teacher.

Saahil eschews the expert's concern about his imprecise question and uses the time instead to add an entertaining video on recycling to fulfill the 5-minute requirement. At the public screening, when several students and the teacher question the jarring ending, Saahil, somewhat exasperated, exclaims, "I didn't know how to end it!" In conclusion, Saahil reasonably adopts the epistemic aim of *remain tied to past knowledge claims* and deploys the epistemic action of *pretend to understand but actually ignore.* This decision may also have reflected that the neighboring teacher belongs to a different community, that the iMovie tool requires large time investments to modify past edits, or that the concepts were beyond his expertise. In summary, Saahil's role as student satisfying task requirements, the separate communities encountered, and the inefficient iMovie tool—all non-epistemic features of the activity system—may have constrained his opportunity to take up an evaluative epistemic aim (e.g. thoroughly investigate information sources about global warming), even when an opportunity falls into his lap.

Student and authority

Second, we examine one case in which the involvement of authority figures impacts the epistemic aim of critiquing knowledge claims. The example involves Jake, who discovers "to his surprise" that his parents disagree over whether violent video games lead to violent real world behavior. Jake himself wavers between multiple approaches to evaluating his peers', his parents', and experts' views on the causal link. At one point, he argues that everyone's views are just beliefs – "There are no right answers." Yet he also expresses a personal commitment to the position that the two variables are correlated but not causally linked, citing his personal experience and explaining, "A friend said pretty much the same thing," a friend who, "is a very intelligent person." He also concedes that the dominant media activist who supports the opposing causal position, Jack Thompson, "is credible, trying his hardest" and "credible, as long as [he has] the research." In his assignment on

discussing oppositional viewpoints, Jake explains that, "Jack Thompson does not have the elbow room to lie about anything." Finally, Jake suggests that he feels "open critiquing [his] mom's [causal] view" even though he says she is an expert because she works with children. These multiple excerpts, which took place over two weeks in interactions with the researcher and in written assignments, suggest that Jake can adopt a variety of approaches to dealing with the causal claim – *knowledge as coming partly from personal experience* (in his own and his Mom's case), *knowledge as resulting partly from hard work* (in Jack Thompson's case), and *knowledge as coming partly from intelligent others* (in the peer's case).

What might we conclude is Jake's epistemic aim in these interactions? Though he appears committed to the position that only an association exists between violent video games and real-world violence, and in fact bases his documentary on promoting this argument, he also hedges the strength of this claim in conversations with the researcher and in his written assignments (e.g. "There are no right answers"). Jake has entered a complex epistemic and social space. He is reluctant to make the strong claim that Jack Thompson is wrong in some settings but not in others. For example, he critiques Thompson in his final documentary, where he includes multiple cartoon strips criticizing Thompson and even includes the phrase, in small print appearing briefly at the bottom of the screen, "Former Attorney – [illegible] – [illegible] MY SOUL." Even though the latter comment is likely a joke targeting his peers or even an absurdist commentary on the link between video games and real world violence, we see a tendency in Jake to exhibit his disagreement with Thompson. The variation in his criticism of Thompson suggests an epistemic aim that teeters between *understanding, criticizing,* or *wishing away* another's opinion depending on the target discourse participants (peers or teacher/researcher).

Teacher and student

The third context we examine is the student-teacher interaction. In many instances in the present data set, the teacher directs the whole-class discourse from an authoritative position, while the activities the teacher asks students to engage in are largely geared toward critiquing and evaluating sources of knowledge. Accordingly, the teacher demands from an authority position – e.g. through phrases such as *Look for*, *Don't just*, *I want you to*, *Back to work*, *Don't push me today* – that students become evaluators, critiquing the sources and methods of science claims in the media – e.g. through phrases such as *Show either similarities or differences between media coverage* and *What makes a source of information good, reliable, trustworthy*? These opposing spaces in the classroom discourse essentially divide the student into at least two roles. One role requires the student to defer the selection of many goals and time investments to an authority, while in the next moment, another role demands the student stand up to authority in the media, to parents, and peers. Some testy interactions occurred in the classroom as students grew accustomed to having voice and independence in some roles but not in others.

One exemplary moment is noted in the teacher's reflective journal. The teacher had taken control of the students' computers and locked them to keep students focused on the whole class activity. Multiple students criticized the teacher's move: "This is like how some governments shut off the Internet at certain times to watch only government programming," "It is really ironic," "You're being hypocritical." The teacher, in turn, wrote in his journal that, "I knew I was asking these students to insert themselves into a really unusual space, encouraging them to exercise their freedom and voice, while still adhering to my authority as the teacher asking them to complete assignments." The event sheds light on how what we typically consider non-epistemic features of social relationships – the power of the teacher to control top-down the students' access to resources – may spill over into the power, voice, and emotions students tap into in their roles as evaluators in the science activity. The whole-class discourse context, in which the teacher adopts the role of an authority, essentially clashes with the epistemic dimensions of the activity itself, which encourages students to adopt evaluator roles, and the students clearly pick up on that contradiction.

Student and peers

In the final interaction space, we examine discourse around knowledge that occurs in relationships between students and peers. In the example, a student named Manish is arguing with his peers and we find that a personal connection to the content impacts Manish's epistemic aim. In the interaction, Manish takes up an argument with his peers about the popularity of a soccer video game that he loves to play. His peers argue that a first-person shooter game is the most popular game and they turn to the Internet to find statistics about which game has sold more copies. It turns out that the first-person shooter game is the highest selling game at that time. Manish challenges the source of the statistic and adamantly states that it is not enough proof. Whereas Manish trusts statistics about smoking (his topic for his documentary film), he rejects the quantitative evidence in the video game context. Manish seems to have adopted the epistemic aim of *defending a personal conviction* (love for soccer, which he expresses by wearing soccer jerseys to class and watching soccer games online during class time) and is willing to deploy the necessary actions to achieve that aim, *questioning the source of empirical data*, even if that action may not be called for elsewhere. Other non-epistemic variables could in principle have influenced the adoption of Manish's epistemic aim. For example, Manish may have wanted to win an argument

with a peer, antagonize another student, or avoid working on his own documentary. If none of these factors were relevant, Manish could have had the pure epistemic aim of discovering the truth of which game sold more copies.

Discussion and significance

This study attempted to document how some variables mediate the adoption of epistemic aims and actions in multiple contexts within the classroom, taking into account non-epistemic factors such as social role, task constraints, personal affiliations with topics, and discourse participants. Our analysis shows that the full activity system in and beyond classrooms interacts meaningfully with the core epistemic goals of curricular tasks themselves. The present methodology, which involves examining discourse between students, peers, and teachers and multiple artifacts produced along the way, provides a cross-context angle on how some non-epistemic variables mediate epistemic cognition.

We described several contextual variables that appear to drive the formulation of epistemic aims and the consequent selection of epistemic actions—constraints that arise from adopting a student role to work through the activity itself, discourse participants that enable or constrain opportunities to critique authority, dimensions of teacher authority compatible or conflicting with the epistemic aims of class tasks, and personal affiliations with a topic. We see that epistemic aims, in part, reflect values established in students' roles and relationships in the social world, such that an epistemic aim (e.g. trying to understand or trying to critique) forms because it serves as an avenue to accomplish a much broader goal potentially unrelated to knowledge.

To what extent does repeated acquiescence to the demands of teachers when it comes to prioritizing certain class goals and activities carry over into students' willingness to confront authority figures – such as science experts interviewed in the media – when students evaluate public science topics? How do students balance competing goals between maintaining an evaluator role and dealing with the constraints – both long-term factors and minutia – that arise in the task environment itself? In future research, we should investigate how students negotiate the overarching epistemic goals of an activity with the pragmatic constraints and affordances of the full activity system. We would expect epistemic cognition around a particular domain in a particular context is as much a product of the design of the learning space – including how members of the space treat each other and how the teacher negotiates norms and task goals with students – as a product of the knowledge itself. In this way, the factors that lead to the deployment of epistemic actions include non-epistemic variables. As these variables change, students' enacted epistemic practices tap into different parts of the their state space for engaging with knowledge. By making the opportunity available to observe whether epistemic cognition is situated, we found that the challenge of working with students to become evaluators of science in the media may involve a much larger initiative—teaching students how to respond to situations in which they have reduced power and voice, constraints on time, and social relationships in which participants have arrived at different conclusions.

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