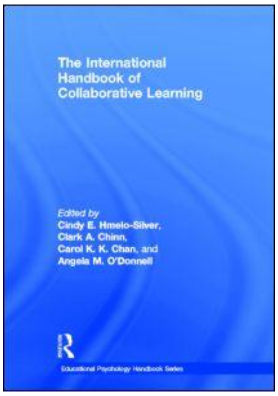

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ORGANIZING COLLABORATIVE LEARNING EXPERIENCES AROUND SUBJECT MATTER DOMAINS

The Importance of Aligning Social and Intellectual Structures in Instruction

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Outside of institutions of formal education, students participate in a variety of social practices in their communities, each, as Nasir, Rosebery, Warren, and Lee (2006) describe, involve "diverse repertoires of overlapping, complementary or even conflicting cultural practices" (p. 489). These authors advocate a position that students' ways of knowing and communicating are developing skills which they bring with them into the classroom, and which inform the ways in which they interact with the content of the curriculum and the social and intellectual practices of instruction. Subject matter areas, or disciplined ways of knowing,[1] also embody distinct social practices and ways of interacting which experts draw upon when engaging in their professional communities (Lemke, 2001). Learning scientists, for example, routinely engage in practices of reading others' research in peer-reviewed journals, using these findings to bolster their arguments for novel research, engaging with trusted colleagues to receive feedback on early versions of their work, and submitting finished papers to conferences or to relevant journals in their field. Discussions among learning scientists rely upon shared sets of terminology and references to works which are assumed to be widely read by members of the academic community. Additionally, learning scientists make particular assumptions about how learning ought to be studied and they design research to investigate aspects of learning with human subjects. As disciplines are applied to formal schooling contexts, these ways of engaging are often masked within a generic mode of instruction which Bruner (1960) referred to as the "middle language" of schooling practices. In school communities, that is, dialogue is often limited to students' reproduction of "right" answers and is similar across subject matters, not reflecting important differences in how knowledge is organized in respective fields (Schwab, 1978). Current trends in education, however, have advocated for bringing disciplinary engagement with the subject matter to the fore in curriculum and instruction (Engle & Conant, 2002; Hatano & Inagaki, 1991). Having students engage in curriculum which is organized around sets of ideas such as experts draw upon in their respective domains has been discussed in the learning sciences literature as necessary to promoting meaningful opportunities that can be transferred or adapted to new types of problems (National Research Council, 2007a).

In this chapter we will consider how collaborative learning coupled with rich contexts of disciplinary problems and questions has the potential to serve as a bridge between students' out-of-school and in-school lives, and to achieve important social and intellectual goals concomitantly. The framework we utilize in this chapter to engage with and organize this complex network of ideas is a model of instruction called project-based learning (PBL). PBL is an approach to instruction that makes explicit important features of the discipline being studied, and positions students as active contributors in the creation of their own knowledge (Krajcik & Blumenfeld, 2006). Krajcik and Blumenfeld propose four main theoretical bases for project-based learning: (a) active construction; (b) situated learning; (c) social interactions; and (d) cognitive tools. We consider these four points and their interconnections as a way to explore the dynamic interplay between collaborative learning and domain-specific instruction.

ACTIVE CONSTRUCTION

We approach the study of collaborative learning with the goal of promoting effective student learning. Research into how people learn has generated overwhelming evidence that students do not come to the classroom as blank slates to be written on, or empty vessels to be filled. Rather, students actively construct knowledge for themselves, utilizing their current forms of understanding to make sense of new material, narratives, and tools which are introduced into the classroom community. Instruction is therefore most effective when it explicitly engages students' prior thinking (National Research Council, 2007a) and builds upon forms of discourse that they utilize in their out-of-school interactions (Lee, 1995; Nasir et al., 2006). Using students' prior knowledge of real world situations has been described as a powerful resource for building new conceptions of the subject matter (Lemke, 1990; J. P. Smith, diSessa, & Roschelle, 1993).

Involving students in constructing their own knowledge and integrating their prior experiences requires curricula which motivate this type of engagement and allow students to become personally invested in the processes and products of their learning. Employing *driving questions* (Krajcik & Blumenfeld, 2006) and problematizing the subject matter (Warren & Rosebery, 1996) can provide the necessary framework and motivation. A driving question is defined by Krajcik and Blumenfeld as a question which "encompasses worthwhile content that is meaningful and anchored in a real-world situation" (2006, p. 320). Used as a beginning to knowledge building, this instructional practice helps to develop students' interests in the solution of problems that they find meaningful, organizes their engagement with the curriculum, and provides a coherent context for students to engage in a range of disciplinary practices and intellectual activities.

SITUATED LEARNING: DOMAIN-SPECIFIC KNOWLEDGE AS AN IMPORTANT CONTEXT FOR LEARNING

Where the tenet of *active construction* of knowledge can inform educators of how to effectively construct learning environments (e.g., by employing driving questions to motivate lessons), a focus on "situated learning" broadens the contexts that one needs to consider when thinking about the trajectory of learners over time in their learning communities. Situated learning as a theory refers to how people come to participate and learn in real-world situations, through a process that Lave and Wenger (1991) termed *legitimate peripheral participation*. This perspective on learning describes how novices become experts through their increased participation in a group's social and intellectual practices over time. Learning in this way is profound; it engages not just the learner's intellect, but his or her emotions and interests, and motivations to belong and to become. Nasir's research on African American students' participation in playing dominoes (2005) and basketball (2000) exemplifies how participants in these activities gained mathematical understanding through their engagement in games which they enjoyed and strived to become more expert players. Formal schooling environments, even when they promote students' active construction of knowledge, typically remove students from direct participation in the professional communities of practices that the curriculum attempts to represent through the school subjects. It therefore becomes necessary to innovate curriculum which brings these knowledge-making practices into the classroom in ways that represent the types of meaningful problems which experts in the domain think about and how they go about solving these problems.

Where prior knowledge is a starting point, the goals of instruction in moving toward these domain-specific knowledge practices include bringing students into contact with normative ways of interacting with content, creating arguments, evaluating evidence, and crafting products. Having access to these disciplinary ways of thinking provide learners with powerful frameworks to interpret their prior experiences and to integrate them with what is learned in the educational setting. Smith et al. (1993) find that the "knowledge of the discipline one is studying affects people's abilities to monitor their own understanding and evaluate others' claims effectively" (p. 12). Vygotsky (1978) similarly described that "learning is more than the acquisition of the ability to think; it is the acquisition of many specialized abilities for thinking about a variety of things" (p. 83). Hence, in the same way that informal learning can be situated, the construction of knowledge in school settings might be shaped to resemble situated thinking about important types of problems using strategies most effective to those ways of understanding the world.

Academic interest in the theory and practice of teaching disciplinary, or domain *specific*, ways of thinking, in contrast to domain *general* thinking practices,[2] has been developing over the past 50 years (see Hirschfield & Gelman, 1994). In education, Bruner (1960) sparked this movement toward domain specific practices in schools, as he argued that each subject has its own structure of knowledge which can guide students' interactions with the content at every level. Schwab's writings on the structure of disciplines (1962, 1978) similarly argued the point that knowledge is organized in ways which help us to define the scope of our questions and to provide guidance in choosing methods which might address unresolved problems that exist in its study. Research in education has since come to rely more and more on domain specific theory both to explain learning (Perkins & Salomon, 1989) and to organize instruction (Driver, Newton, & Osbourne, 2000; Lemke, 2001; Schulman & Quinlan, 1996; Stevens, Wineburg, Herrenkohl, & Bell 2005). The National Research Council (2007a) describes this as having a knowledge-centered focus on learning and instruction, where core concepts in the subject matter are emphasized by providing concrete cases and detailed knowledge to assist students' ability to achieve mastery of those core concepts.

Much of what defines a domain are the ways in which scholars working in that tradition think about the subject matter, create arguments, and the types of discourse they use to support those arguments. In history, for example, Lowenthal (2000) describes five "modes of thinking" which he sees as being specific to that domain: (a) having *familiarity* with a common set of references; (b) using *comparative judgment* to think about and critique differences between sources; (c) having an *awareness of manifold truths* (i.e., that different viewers are bound to see a past event differently); (d) keeping an *appreciation of authority* where sources are respected but not venerated; and (e) developing *hindsight*, in that interpretations of the past can change as new evidence becomes available. The development of disciplinary epistemologies or ways of conceptualizing knowledge within a given domain is the result of engaging in these types of practices and ways of thinking about the subject matter. Hofer's (2002) research found, for instance, that by college, students hold differing beliefs about the certainty and stability of knowledge across domains such as science and psychology. For students just beginning to engage in these practices for the first time, their ability to express such formal epistemologies around the subject matter may be limited. Evidence of a *practical* or *personal epistemology*, defined as students' general views about the nature of knowledge and knowing (Elby, 2009), can be gleaned from the ways in which they interact with knowledge during inquiry (Sandoval, 2005), even when students do not reflect explicitly on them.

There are important distinctions to note in how "domain" is defined by different theorists in the research on teaching and learning. Some scholars use the term *domain* to indicate subfields of conceptually coherent subject matter. Inagaki and Hatano's (2004) work, for instance, identifies how children organize their own understandings of the natural world into the domains of physics, psychology, and biology. Their work concludes that children use different causal devices to explain biological processes, and in this way differentiate between living versus nonliving things. These distinctions are, of course, relevant to the larger fields of study that they correspond to, and some researchers necessarily focus on the ways in which conceptual change must encompass strategic ways of thinking about particular types of problems within these content areas (diSessa, 1993).

For students' growing understanding of subject matter to be situated within contexts of disciplinary learning, it is also necessary to consider what level of specificity in domain-specific knowledge and practices is ideal for younger learners to engage with. In school subjects, there are often broad demarcations of domains such as science, social studies, and mathematics, though we know from the research literature that subfields within a domain can differ in their disciplinary practices and epistemologies. Samarapungavan, Westby, and Bodner (2006) have found, for instance, that the self-described work of chemists differed from normative views of science as a primarily theory-building pursuit. These distinctions may be more readily apparent and their epistemological underpinnings more accessible to exploration by students in the upper grades and at the university level, where content knowledge is typically already divided into subfields of inquiry (e.g., "social studies" in lower grades becomes economics, geography, and history in upper grades). At the elementary and middle levels, while these distinctions inform the big ideas and concepts that students engage with in exploring knowledge within the domains, introducing core sets of thinking practices that transverse the domain more broadly defined (e.g., science) have been more common in the literature (National Research Council, 2007b). Examples of this from science include research on developing students' ideas about theory building, revising ideas over time, and how models can be used to represent thinking (Beeth & Hewson, 1999; Kawasaki, Herrenkohl, & Yeary, 2004). In mathematics, research has explored how teachers can engage students in position-driven discussion of mathematical ideas (O'Connor, 2001) which develop their understandings of the relationship between conjecture and proof (Lampert, 1990). There is a usefulness in considering both these broader epistemologies and disciplinary practices that we would like to engage students in, along with the nuanced conceptual understandings of particular subfields within disciplines. For our purposes in this chapter, we focus on the larger distinctions between disciplines (e.g., science, history, mathematics) and consider the ways in which collaborative learning can be used to facilitate disciplinary epistemologies.

SOCIAL INTERACTIONS: COLLABORATIVE LEARNING AND THE DEVELOPMENT OF DISCIPLINARY EPISTEMOLOGIES

Sophisticated models of using collaboration in the classroom emphasize that this instructional tool involves much more than simply putting students together in a group, giving them a problem, and asking them to find solutions. Barron's (2003) work illuminates some potential roadblocks to effective collaboration, namely, that groups can fail not because of the lack of effective intellectual ideas and tools, but rather due to the fact that they are unable to negotiate the relational demands of working together in a group, such as responding to each other's ideas and integrating them when warranted. Effective collaboration, as defined by Hmelo-Silver and Barrows (2008), involves participants in sharing responsibility for learning, distributing expertise, and building on each other's ideas. These images of collaboration build off of Brown and Campione's (1994) and Rogoff's (1994) theoretical discussions of *communities of learners*, where students are positioned as active in building understandings and teachers serve as guides. One important feature of this model of collaboration is the notion of distributed expertise, where individual students within a classroom community are positioned as being experts on different topics or problem-solving skills, and are asked to leverage each others' abilities in developing collective products and solutions. Slavin's (1999) model of collaboration similarly emphasizes individual accountability, where each person's contribution is expected and assessed, and group goals, where the group collectively works toward some understanding or solution. Discourse is utilized in collaborative learning environments as a way of sharing and building knowledge, and as we will discuss later in depth, is also situated within different domains of knowledge and types of problems to be solved.

Collaboration within models of collective, classroom-based, and constructivist learning affords students both social and intellectual benefits.[3] Though not truly separable, we will consider each of these in turn. The social benefits of collaboration include increased opportunities for individual students to participate, equalizing status differences among students (Cohen, 1994; Cohen & Lotan, 1995); providing students with the chance to negotiate their ideas with each other (Warren & Rosebery, 1996); and emphasizing group goals along with individual accountability (Slavin, 1999). We represent these aspects of collaboration as a foundational set of relations in a classroom which must be developed, in some form, before successful collaboration in a domain can be achieved, though certainly they continue to develop through sustained disciplinary engagement. Students' experiences using discourses germane to normative disciplinary practices can, in turn, impact and become a site for exploring the social relations among students and teachers. For instance, using our previous example, if students were to engage in investigating problems as learning scientists do, they may begin to utilize terminology which they have encountered in seminal pieces of work in the field, and may frame their own investigations with human subjects around these ideas. The process of engaging in such research may raise questions for the community, collectively, about the role of the researcher in both collecting and sharing information with colleagues. Disagreements about what forms of knowledge "count" and could advance the collective understanding of a common set of issues, can thus lead to discussion and reflection on the ways in which the group itself is functioning as a community of learners (Rogoff, 1994). Wortham's (2004, 2006) account of students' discourse in a literature unit, and Lensmire's (2000) account of writers' workshops illustrate how social relationships in the classroom constitute and are reconstituted by the curriculum.

The intellectual benefits of collaborating within disciplinary structures of knowledge include increased opportunities for students to practice speaking, for example, the "language of science" (Lemke, 1990) as they interact with each other. Collaborative learning presents opportunities for students to assume ownership of ideas and to use persuasive discourse as a means of creating arguments that their peers will find compelling (Cornelius & Herrenkohl, 2004). This negotiation of ideas with peers helps to develop "epistemic motivation" (Hatano & Inagaki, 1991; Sandoval, 2005) to know and understand the subject matter. Students can learn about scholarly practice within the domain through the activity of using evidence and defending their ideas to one another.

There are ways to introduce disciplinary ideas and discourses into a classroom which do not necessarily involve collaboration among groups of students. Nathan and Kim (2009) for instance focus on one teacher's role as facilitator of whole class conversations and his central role in scaffolding disciplinary ways of thinking through skilled elicitations of students' ideas. Conversely, there are ways of providing collaboration opportunities for students that are not explicitly disciplinary. Cohen and colleagues (Cohen, 1994; Cohen & Lotan, 1995; Cohen, Lotan, Scarloss, & Arellano, 1999), for example, focus on the nature of students' engagement with each other during classroom tasks which have been differentiated to provide multiple ways for students to engage with the material, but which do not promote disciplinary epistemologies specifically.

Collaborative learning which integrates a concern for social relations among students with disciplinary considerations for learning, however, can achieve powerful results in getting students to think and act more like mature practitioners of a discipline. Researchers of inquiry based classroom curriculum agree that the productiveness of inquiry depends on the scaffolding that the teacher provides, for both the social and intellectual activity of the classroom. Students must be introduced to an idea of "rights and responsibilities" to define their own roles in relation to others during their inquiry. Teachers must also introduce students to the key features of thinking in a given discipline: the kinds of questions one asks, the methods one uses to answer those questions, and what counts as evidence in a given domain.

Cognitive Tools

Representing disciplinary practices and ways of thinking in the classroom is a complex process which requires more than a teacher's explanation of the key features of the discipline, or the students' developing efforts and abilities to work together to solve problems. To bring students closer to the work that experts in the field are doing, it is necessary to introduce cognitive tools that guide students' active construction of knowledge within domain-specific practices while also facilitating collaboration which is an essential feature of any community of practice. Sociocultural theories of teaching and learning emphasize that understanding learning requires an analysis of the "cultural tools" one is using and how they mediate social and intellectual activity (Wertsch, 1998). Uses of technology, prompts, and classroom texts, along with the forms of discourse and evoking common narratives constitute some of the many ways in which classroom activity is shaped toward particular ends.

There are many examples of tools and approaches that have been developed to support students to learn to embrace discipline specific thinking strategies and which often concomitantly support effective collaborative learning as students share their ideas and work to build a collective understanding of the subject matter. Approaches to literacy instruction like Palinscar and Brown's (1984) classic model of reciprocal teaching externalize strategies that expert readers used as a way to explicitly support and guide novice readers struggling to comprehend text. Model-based reasoning approaches in science support students in developing and testing models as forms of scientific understanding (Lehrer & Schauble, 2004; Penner, Giles, Lehrer, & Schauble, 1997; C. A. Smith, 2007; C. Smith, Snir, & Grosslight, 1992). Scaffolding students' participation in scientific inquiry and argumentation has also produced sets of instructional tools to guide students as they work to make connections between claims and evidence (Bell & Linn, 2000; Herrenkohl, Tasker, & White, 2001; Reiser et al., 2001; Sandoval, 2003; White, 1993; White & Frederiksen, 1998). History instruction has produced approaches that assist students to understand essential features of thinking historically such as asking and answering essential historical questions, finding and evaluating relevant sources to answer questions, reconciling conflicting accounts of events, and creating interpretative accounts by synthesizing the evidence (Levstik & Barton, 2005; Seixas, 1994; Stevens et al., 2004; VanSledright, 2002).

DIFFERENCES AND SIMILARITIES IN COLLABORATION ACROSS DOMAINS

The foregoing discussion of supporting social and intellectual goals concomitantly in the classroom by employing cognitive tools which support collaborative learning within domain-specific areas of inquiry begs some questions: Do forms of collaboration differ across subject matter? Are there ways of talking and working together that are more relevant to some domains than others? What kinds of differences in visual representations or prompts would we expect to see to support collaboration toward domain-specific goals? In the broad area of research on collaboration which can range from descriptions of collaborative learning in which developing professionals engage in the practices of their field (Hmelo-Silver & Barrows, 2008) to groups of children engaging in scientific inquiry for the first time (Herrenkohl & Guerra, 1998), we recognize that it can be difficult to generalize what types of supports might be needed. For this reason, we will treat our discussion of these issues as an exploration of possible theoretical connections between collaboration and domain-specific learning.

In this section, we explore these questions through considering two disciplines, science and history, which we have personally studied in elementary classrooms with the explicit purpose of comparing students' disciplinary epistemologies (Stevens et al., 2005). We compare, first, the research literatures on history and science teaching and learning, and explore potential similarities and differences in the types of collaboration being proposed. We then turn to our own research program to highlight the following:(a) the common supports that we used across disciplines; (b) the ways in which we adapted these supports to the discipline-specific ways of thinking we were hoping to communicate to students; and (c) how these structures supported differences and similarities in argumentation across subject matters. We will then turn to a discussion of how these linkages might be utilized for a deeper understanding of the conceptual connections between domain specific practices of disciplines with the domain general practices of collaborative learning used in educational settings.

Collaboration in Science

Collaboration in the science classroom is deeply interconnected with principles of inquiry-based learning which can guide students' investigations into scientific ideas. According to Lemke (2001), science is essentially a social process where "what matters to learning and doing science is primarily the socially learned cultural traditions of what kinds of discourses and representations are useful and how to use them" (p. 298). If we represent science in this way as a social process, it follows that students' learning in this discipline should also represent the process, instead of merely focusing on the products of scientific inquiry, as has historically been the case in many science classrooms. Creating opportunities for students to collaborate in this process provides them with the space for developing sophisticated discourses and representations that resemble the practices that scientists routinely engage in.

Several programs of research in science education have been pivotal in exploring how students' scientific understandings are facilitated by collaboration and discussion. Rosebery and Warren's work in the Cheche Konnen Center for Science Education Reform (Rosebery,Warren, & Connant, 1992; Warren & Rosebery, 1995), research on Sister Gertrude Hennessey's exceptional teaching practice (Beeth & Hewson, 1999), and Herrenkohl and colleagues' research in elementary science classrooms (Herrenkohl & Guerra, 1998; Herrenkohl, Palincsar, DeWater, & Kawasaki, 1999) have provided powerful examples for how these practices can be made accessible to students within their own collaborations in the classroom. Herrenkohl's work has focused on how to make the intellectual practices of scientists visible to students by asking them to take on these roles themselves, both in small-group work and in whole-class conversation. Three scientific intellectual roles that Herrenkohl introduced to students included having students think and ask questions about (a) predicting and theorizing; (b) summarizing results; and (c) relating predictions and theories to results. Rotating through these roles on different days helped students to monitor their own and their peers' thinking. Over time, students engaging in these discussions of theories and interpretation of evidence can develop a sophisticated epistemology of science by participating in science as a process of revision.

Effective communication among students in science also depends on their ability to visually represent complex ideas and findings to one another. Bell (2004) and Bell and Linn (2000) focus specifically on representations, or argument maps, that students created to develop their thinking. Such visual representations help students to see how various pieces of a scientific topic connect, and to understand how and where their peers' thinking departs from their own. Collaboration is greatly facilitated by having such common structures through which to compare differences in thinking.

Collaboration in science often involves engaging students in small-group work to complete their investigations, which is followed by discussion at the classroom level to present and discuss their findings. In science, theories may be developed directly from experimental evidence. Theories can also be created by evaluating evidence collected by other means. Engle and Conant's (2002) work in the Fostering Communities of Learners research program describes how students used a variety of sources to inform their thinking about endangered species, including a visit to the local aquarium. With this evidence in hand, students can then go about the task of reading and assessing the validity of others' scientific ideas and experiments.

Engaging students in genuine attempts at scientific inquiry can create the conditions for realizing that different explanations might come to bear on interpreting scientific data. Working collaboratively encourages students to push for greater clarity in their explanations. Palincsar and Herrenkohl (1999) define collaborative work as a process of convergence which can be "achieved through cycles of display, confirming and repairing shared meaning" (p. 152). Efforts to reconcile differences in explanations provide opportunities for students to revise their own thinking in light of better evidence, arguments, and theories. Collaboration in science thus requires scaffolded opportunities for discussion in both small groups and whole class discussions, as well as representations for making their thinking visible to themselves and to others.

Collaboration in History

As in science, educators of history often find themselves in an uphill battle of trying to convey their field as a process of knowing, as opposed to a collection of facts. Argumentation is central in creating and evaluating historical accounts (Hexter, 1971). Students engaging in historical analysis are every bit as much engaged in inquiry as they are in science because they must learn to evaluate sources of evidence, to reconcile differences in historical accounts, and imaginatively take into consideration the context in which pieces of evidence were created (National Center for History in the Schools, n.d.). While there are similarities between history and science in their requirements for evidence-based arguments (Stevens et al., 2005), Lowenthal (2000) argues that history is different from natural and social sciences in that it "has no technical jargon" (p. 63), rather it requires a set of skills that one needs to think about issues of context, truth, and evidence.

When students work collaboratively in historical inquiry they can, as in science, engage in processes of developing and revising their ideas and arguments over time. The function of collaboration is to get students to externalize their thinking by together negotiating their ideas and understandings of the texts. Bain's (2000) work in history instruction emphasizes that students benefit from participating in a classroom where historical accounts are jointly created and shared, stating that "participation in such a community creates opportunities for students to internalize the discipline's higher functions or expertise" (p. 336). Bain's approach to teaching history draws on Palincsar and Brown's (1984) model of reciprocal teaching and resembles Herrenkohl et al.'s (1999) work in science, where complex understandings of history are possible when students divide the task of creating a complete and complex historical analysis of a document or group of documents. Each student in the group asks questions concerning a particular practice in reading historical documents: source, intended audience, story line, corroboration, or purpose of source.

Historical inquiry in the classroom, as in science, can be facilitated by the use of visual representations for students to develop and communicate their ideas to one another. As we will discuss with respect to our own research in Promoting Argumentation, argument maps similar to Bell's (2004) were adapted to the history curriculum as a way for students to organize their evidence, see connections between evidence and particular arguments, and to map out a physical space in an historical account (a Montgomery, Alabama bus from the historical event involving Rosa Parks).

The literature in science and history instruction, then, point to some similar themes in promoting collaborative learning in the classroom including: (a) the centrality of inquiry-based explorations of the subject matter; (b) promoting evidence-based argumentation in students' interactions with each other; (c) giving students intellectual roles which represent disciplinary ways of thinking to assist collective knowledge building; and (d) the importance of providing students with visual ways to represent their ideas to one another. There were few differences noted in the collaborative aspects of engaging students in this literature, though we note that there are fewer works on collaboration specifically related to historical inquiry in the classroom to compare with science. We turn now to our own research, which explored these disciplines side by side, to consider whether there is anything unique about collaboration in each domain, and what effect there might be on student learning when a focus on developing disciplinary epistemologies is infused in a classroom environment that promotes collaboration.

OUR CROSS-DISCIPLINARY RESEARCH

Our research in Promoting Argumentation involved the comparative study of two school subjects, science and history (see Stevens et al., 2005). In this section, we will explore both the common collaborative structures which functioned across domains, and also the ways in which the disciplinary structures of these two subjects gave rise to emergent differences in students' approaches to collaborative work.

In Promoting Argumentation, we were primarily interested in how upper elementary students (Grades 5 and 6) could develop comparative disciplinary epistemologies across two subject matters. Across one school year, we engaged students in each area of inquiry, history and science, separately through two units of science and two units of history. A final unit combined scientific and historical inquiry in a unique way, to assess how students were becoming aware of when they were engaging in scientific versus historical ways of thinking. For the purposes of this chapter, we focus on the two main units in science and history, which took place around the middle of the school year: Sinking and Floating in science, and Rosa Parks in history. Each unit contained driving questions which shaped students' own investigations into the subject matter. Instruction was also provided in the beginning of each unit, to introduce ideas of what it might mean to think scientifically or historically. For example, in Sinking and Floating, a lesson called the Orange Experiment took place at the beginning of the unit. This lesson required students to make predictions about whether a whole orange and an orange slice would sink or float, develop theories to account for their predictions, and refine their theories based on the experimental evidence. In the history unit on Rosa Parks, a lesson called the Playground Fight involved students in thinking about an imagined fight scenario, which introduced them to ideas about differing points of view, gathering and interpreting multiple sources of evidence, and making a decision about what happened based on divergent sources. These introductory lessons laid the groundwork for students to engage in discipline specific inquiry in each of these subject matters by bringing awareness to issues of evidence and the interpretation of evidence in each domain.

Scaffolding Collaboration: Common Supports across Disciplines

There were several instructional supports and participant structures (Philips, 1983) which were utilized in both subjects and aligned with other findings from the literature on collaboration in each of these domains. In this section, we focus on the similarities in the structures and practices that we introduced into the classrooms. In the following section we will focus on how these were adapted to different disciplinary goals. First, there were three key participant structures which provided opportunities for collaboration: whole-class teacher-led instruction, small-group work (four to five students per group), and whole-class presentations in which each group shared their findings and were questioned by other groups that comprised the “audience.” Second, in both subjects, students engaged in inquiry in their small groups with the support of SenseMaker boards, adapted from Bell’s (2004) software designed to scaffold argumentation in science. White boards (approximately 2’ x 3’ in size) were used in place of the software in Promoting Argumentation to ensure that students in all of the schools had access to this cognitive tool. The design space of the boards was organized differently across subject matters, which will be discussed in depth in the following section. The SenseMaker boards functioned both as a space for the small groups to record and revise their thinking based on their collaborative inquiries, and as a means for presenting their findings to the whole class. A third instructional support was the introduction of intellectual audience roles similar to those devised by Herrenkohl and colleagues (Herrenkohl & Guerra, 1998; Herrenkohl et al., 1999) to support students in asking questions of each other that reflected disciplinary ways of thinking about theories and evidence. During whole-class presentations, each audience member was assigned an intellectual role, where each corresponded to key thinking practices in each discipline, and these roles rotated so that each student could participate within each role. A “questions chart” was generated by the whole class with the teacher’s support at the beginning of presentations to ensure that students had examples of what types of questions could be asked within each role, and these charts were displayed so that students could draw on these ideas during the presentations. Intellectual audience roles and questions charts involved students in a form of whole-class collaboration which stressed their responsibility as audience members to understand the presenting groups’ arguments and to make critiques if necessary. A fourth instructional support was a “theory chart.” In each subject, chart paper was used to provide space for the class to record new theories following groups’ presentations. The theory chart helped the class to collectively keep track of their ideas and, at the end of the unit, to evaluate which arguments held up best to the evidence which was presented and explored during the unit.

Differences in the Common Supports across Disciplines: SenseMaker Board

The science unit on Sinking and Floating engaged students in a sequence of four experiments, where each set of experiments was designed to test one variable at a time and think about whether a theory involving that variable could explain why things sink or float. The objects were similar across experiments (small objects of varying materials, sizes, and shapes). The SenseMaker board was designed so that students would first order their objects according to that particular variable (e.g., size from largest to smallest) and make predictions about whether each would sink or float. For each set of experiments, the small group was required to come up with a theory to explain their predictions, to record their results next to their predictions, and to note any changes to their theory after the experiment as they took into account their results. The design of the board promoted an iterative process of creating predictions and theories, collecting data, examining the data, and then reevaluating the theories.

In history, the SenseMaker boards were designed in two different ways, one for each question about the historical event involving Rosa Parks on the Montgomery, Alabama bus. The first question in the unit asked "Where did Rosa Parks sit on the bus?" For this question, an accurate diagram of the Montgomery city bus was placed in the center of the board. After reading through 15 pieces of evidence from an archive bin, students placed small sticky-notes corresponding to these pieces of evidence on the board surrounding the bus, indicating where they ascertained each text said that Rosa Parks sat. Pieces of evidence that were not relevant to the question could be placed in a section at the bottom of the board labeled "irrelevant." For the second question "Why did Rosa Parks stay in her seat?" the boards were organized such that there were two columns: on the left, students recorded the different arguments that they saw emerging from the sources in the archive bin, and on the right, they placed the sticky-notes to indicate which pieces of evidence supported those arguments. A space for documents which were irrelevant to the question was again provided at the bottom of the board.

Intellectual Audience Roles

To scaffold students' disciplinary epistemologies, different intellectual roles were provided for each subject. In science, these roles were: (a) predicting and theorizing; (b) summarizing results; and (c) relating predictions and theories to results. These roles were introduced just before whole-class presentations began and referred to aspects of the process that students had just engaged in with the first experiment, emphasizing the iterative nature of scientific inquiry. As a whole class, sample questions for the questions chart were generated. Predicting and theorizing questions included, for example, "How did you come up with your predictions?" or "If you thought it would sink, why?" Relating predictions and theories to results included questions like "If you predicted it sank, and it floated, why was that?"

In history, the intellectual roles were (a) sourcing; (b) cross-checking; and (c) imagining the setting. Some questions that were generated for sourcing included, "Was a piece of evidence believable?" or "Why was it written?" Unlike in science, these roles focused less on understanding the groups' own arguments, and more on understanding their use and understanding of the evidence.

These roles did not cover all of the key intellectual practices that we were interested in introducing to students during these two units. Rather, they focused on key processes involved in creating arguments or theories, and discussing the evidence in relation to them.

SIMILARITIES AND DIFFERENCES IN COLLABORATION ACROSS SUBJECT MATTERS

As we anticipated from the literature, and as we planned for in instruction, inquiry was central to students' interactions within both science and history. Driving questions provided by the curriculum framed the investigations in each subject, and students worked to craft their own arguments in response to these questions. The evidence-based argumentation which was promoted in both subjects was taken up by students. Through their inquiry, students were increasingly able to reflect upon what counts as good evidence or a good argument in each domain (Herrenkohl & Cornelius, in press). Additionally, the participant structures and instructional supports that we introduced during Promoting Argumentation produced similar forms of collaboration across science and history. In both subjects, students moved through a familiar sequence of whole-class, teacher-led discussions, to small-group investigations, to whole-class presentations, where groups' ideas were discussed and evaluated toward the goal of creating more robust arguments.

Though the SenseMaker boards provided similar opportunities for students to record, explore, and visually represent their knowledge, as we expected from the literature, there emerged some differences between the two domains with respect to students' understandings of the two disciplines. One difference that we noted was that the positions of students differed with respect to the subject matter. This was related to the types of evidence they were given to work with and the extent to which their own theories were developed from direct experimentation or involved evaluations of others' evidence. The framing of the theory building space on the boards in each unit, along with the use of intellectual audience roles, emphasized different intellectual processes in the use and evaluation of evidence in each domain. Science, on the one hand, was framed through the four experiments in Sinking and Floating as an iterative process, where students must continually revisit their theories in light of new evidence. The questions from the questions chart likewise alerted students to the importance of this intellectual practice, and led to questions in the general form of, "What do you think *now*?" Since we did not introduce any textual resources for students to explore others' thinking on what makes things sink or float, their task was to engage in this series of experiments to develop a theoretical account of Sinking and Floating that could account for the objects tested. Students' roles in this were, primarily, as creators of knowledge and owners of original theories.

Though the analysis of historical documents certainly involves processes of revising one's thinking in light of new evidence (Boix-Mansilla, 2000), this intellectual activity was not as central in students' discussions. Our research on how students, together with their teachers, created arguments across these two units found, in fact, that talk about revising arguments and metalevel discussion about conceptual change occurred about six times more frequently in science than in history, even though history was a much longer unit (Herrenkohl & Cornelius, in press). In history, the SenseMaker boards and intellectual roles focused students more on evaluating evidence and in thinking about how pieces of evidence must corroborate to create a valid historical account. Though students were required to create their own arguments in history as well, these ideas were to be based on the ideas of others: namely, the authors of various historical texts. The demands of historical thought therefore required that students work in the role of evaluators of knowledge, at the same time that they were working to create a narrative/argument of their own.

The specific differences that we found, however, may have also been related to the type of tasks that were given to the students our science unit. Specifically, Sinking and Floating involved firsthand investigations of the phenomenon. Secondhand investigations are also plausible and common ways for students to interact with scientific subject matter, especially when the content is such that it does not allow for students to manipulate objects directly (Palincsar & Magnusson, 2001). Our observations within another unit we implemented, Deformed Frogs, where students relied upon secondhand sources to interact with scientific arguments, suggested that there may be more similarities to history in terms of how students approach and evaluate evidence. When considering secondhand scientific evidence, the sources must be considered, cross-checked against each other, and the student must actively "imagine the setting" of the initial research experiment that is described: processes more akin to historical thinking.

A second, epistemological difference that emerged between the two domains in our research involved notions of "truth." Working with historical documents, which students came to understand as being written by individuals with a certain perspective or point of view, led to considerations of whether the truth could ever be known. Though notions of truth are arguably as relevant to the discipline of science as they are to history, our structuring of the two units may have made this issue more salient in Rosa Parks than in Sinking and Floating. Again, we believe this to be related to the fact that in science, students were engaged in building up their own theories based on raw data, whereas in history they were evaluating claims made by others. A science unit involving students in comparing others' theories and evidence might yield more discussions of truth than we observed across classrooms during Promoting Argumentation.

Though several of these key differences existed between students' engagement in the disciplinary practices of history and science, we found that many similar disciplinary practices also emerged (Herrenkohl & Cornelius, in press). For instance, key practices such as creating arguments, defining what it means to engage in argument building in each discipline, revising arguments based on evidence, and engaging in imaginative and analogous thinking were observed in both subjects. Through engaging collaboratively in the processes of theory building themselves, students were able to push each other to think about the explanatory nature of theories, to decide together what types of evidence should and should not be allowed, and to propose which conclusions were reasonable based on the evidence.

Our comparative approach to engaging students in disciplinary inquiry shows that collaborative structures, in form, do not need to differ widely from each other to engender students' thought and engagement with discipline specific ideas and knowledge making practices. In fact, we venture the hypothesis that having common participant structures and instructional/cognitive tools across school subject matters may be beneficial to students' learning, as they build up predictable routines that free up time and students' cognitive resources to focus on the exploration of the academic content (Tabak & Baumgartner, 2004). When students come to expect these types of relationships with their peers in creating knowledge, they can more easily focus on how their engagement with each other differs from subject to subject, as necessitated by the intellectual work required by each type of inquiry. Our students in Promoting Argumentation were well on their way to discerning the differences and similarities between different types of argumentation required in history and science, and by the end of the school year could reflect on how the work of scientists and historians might proceed.

DIRECTIONS FOR FUTURE RESEARCH

In this chapter, we framed a discussion of domain specific learning as a type of social practice that involves various repertoires and utilizes expert forms of knowledge, parallel to the social practices in which students engage in their out-of-school lives. We believe that future research needs to keep a wider view of the purpose of engaging in domain-specific, collaborative inquiry, to consider the possibilities students are given to develop intellective identities (Greeno, 2002) and to be mindful of who they are "becoming" as students in the process (Herrenkohl & Mertl, 2010). Our task as educators is to ensure that students' out-of-school experiences overlap with their school experiences as much as possible, to strengthen the meaning that students are able to make across the contexts of their lives.

Furthermore, we need to continue to pay attention to ways in which different students connect or fail to connect with different disciplinary ways of knowing and talking. Status differences among students profoundly influence the dynamics of collaboration in ways which can often be difficult for teachers to overcome (Cohen & Lotan, 1995; Lensmire, 2000; Paley, 1979, 1992; Wortham, 2004). Collaborative learning must be utilized in ways that address these status differences and which challenge the typical relationships between students, teachers, and subject matter (Cornelius & Herrenkohl, 2004). Introducing structured collaborative learning opportunities into the classroom environment within rich contexts of disciplinary problems and questions has the potential to achieve both these social and intellectual goals concomitantly and can ultimately lead to a far more important goal for the lives of students: their growing sense of competence and identification of themselves as powerful thinkers and learners.

NOTES

1. We use the terms *subject matter*, *discipline*, and *domain* interchangeably as they apply to classroom instruction.
2. Domain general approaches to thinking and learning have assumed that there are general cognitive processes which can brought to bear on any number of diverse tasks and which can be developed irrespective of the domain.
3. And arguably emotional benefits which we will consider in our directions for future research.

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