

Reimagining Cultural Forms, Ethnographic Methods and Researcher Responsibilities in Studying Engineering and Science Learning: Honoring and Building on the Work of Margaret Eisenhart

Cory Buxton, University of Georgia, buxton@uga.edu

Karen L. Tonso, Wayne State University, ag7246@wayne.edu

Heidi Carlone, The University of North Carolina at Greensboro, hbcarlone@uncg.edu

Angela Johnson, Saint Mary's College of Maryland, acjohnson@smcm.edu

Jrene Rahm, Université de Montréal, jrene.rahm@umontreal.ca

Abstract: Honoring and building on the work of Margaret Eisenhart, this set of papers delimits the myriad ways that four studies have reimagined cultural forms, deployed ethnographic methods, and conceived of researcher ethical responsibilities in studying engineering and science learning. Framed by cultural production theory, critical intersectionality, actor network theory, and a sociocultural-historical stance, these studies illustrate the interconnected nature of learning and becoming processes, the complexity of cultural forms and engineer/scientific identity productions, and the continued salience of structural forces to shape learning and becoming in life-wide settings. Ethnographic methods served these studies well by providing access to time-dependent processes, by immersing the researchers in their field sites over time, and by allowing seeing from the inside out to privilege the perspectives of research participants. Each study found ways to follow individuals and structures simultaneously, and to document cultural forms and variations in the ways insiders took up cultural forms.

Overall Focus and Theme

Sociological and anthropological inquiries into patterns of wealth, social mobility, and opportunity in society, and the role that schooling plays in perpetuating or disrupting these patterns are now decades old. All of us involved in this symposium are engaged in the question of how societal forces influence learning in the contexts of science and engineering. Reflecting the 2014 ICLS theme of *learning and becoming in practice*, we consider how the anthropology of education, and more specifically the scholarship of Margaret Eisenhart, offers important tools and insights for understanding and acting at this intersection of how people learn and how sociocultural forces influence that learning. Connell (1987) coined the term “practice theories” (as opposed to categorical theories) to highlight the ways in which structures that had been taken for granted in prior theories (e.g., social reproduction theory) should become questions for research. Similarly, Levinson, Foley, and Holland (1996) argued that practice theories afford a reconsideration of the permanence of social structures through a close examination of moment-to-moment social practices. By viewing structural categories as impermanent, practice theorists hope to more appropriately balance the disciplining power of social structures with the visible differences in how individuals, who seem to occupy the same structurally defined categories, actively make meaning of the world around them, and exert personal agency within and against those structures (Eisenhart & Finkel, 1998). As Eisenhart (2001) argued over a decade ago,

[E]veryday life, including life in schools, seems to be faster paced, more diverse, more complicated, more entangled than before. The kinds of personal and social relationships, exchanges, and networks we participate in seem to be taking new forms, tying together otherwise disparate people, and demanding some new ways of thinking about what to research and how to do it. (p. 24)

Despite these nuanced understandings of societal forces that are studied within the realm of educational scholarship, there has been renewed enthusiasm within the political and policy realm for viewing schooling as a microcosm of a meritocratic society, in which the smartest, hardest working, and most well behaved students will be rewarded with an education that can be parlayed into a socially and economically successful life (Hursh, 2005). While the argument that education serves as a meritocratic equalizer to socioeconomic disparities has been with us at least since the end of World War II (Themelis, 2008), this neoliberal viewpoint has gained renewed favor in the justifications for our current academic accountability systems (O'Neill, 2013). Powerful tools and arguments are required to push back against this neoliberal tide that paints successful learning, as well as other successes in life, as individual accomplishments. Margaret Eisenhart's work has provided us with some of those tools.

The set of papers in this symposium takes up Eisenhart's challenge of exploring new ways of thinking about how to research structure and practice, culture and identity, within the context of how people learn science

and engineering. While building on Eisenhart's ideas in different ways and in different contexts, all of our work highlights the ongoing value of *attending to cultural forms*, *reinvigorating ethnographic methods*, and *reconsidering the ethical responsibilities of researchers* with an eye toward challenging neoliberal assumptions and promoting more equitable and meaningful science and engineering learning opportunities. We view our work as part of the interdisciplinary field of the learning sciences given our concerns for improving learning through designed educational settings, with a focus on human agency, values, motives, and goals central to the human sciences (Penuel & O'Connor, 2010).

Cultural Production on an Engineering Campus: Learning, Power, and Engineer Identities

Karen L. Tonso

Though anthropologists understand culture to be something produced in everyday activities among a group with a shared life, culture as a concept shifted from being given, to being made, from reproductions (e.g., Connell, Ashenden, Kessler, & Dowsett, 1982), to more open productions (Levinson, et al., 1996; Willis, 1977).

Cultural forms provide the material towards, and the immediate context of, the construction of subjectivities and the confirmation of identity. It provides what were the most believable and rewarding accounts for the individual, his future and especially for the expression of his/her vital energies. (Willis, 1977, p. 173)

As such, individuals moved from *objects* of cultural processes to *actors* in cultural processes. Studies of high school life (e.g., Eckert, 1989; Foley, 1990; Willis, 1977) suggested the salience of schools to frame individuals' actions, to interpret those actions, and ultimately to elevate some ahead of others (Foucault, 1982), and to do so along well-worn societal structures – social class, gender, race/ethnicity – smuggled into life at school.

[I]dentities are improvised – in the flow of activity within specific social situations – from the cultural resources at hand. Thus persons and, to a lesser extent, groups are caught in the tensions between past histories that have settled in them and the present discourses and images that attract them or somehow impinge on them. (Holland et al., 1998, p. 4)

Beginning with a strand of research that fed into *Women's Science* (1998), I was open to possibilities for cultural change that might be allowed in a college setting incorporating out-of-school practices. Here I hoped to document to what extent "Individuals respond to the structural alternatives, and as they do, [if] they actively negotiate and sometimes contest the identities produced for them" (Eisenhart, 1996, p. 183). In many early conversations, Eisenhart asked: "What do people make of their world?," while I persistently wondered "And what does their world make of them?" Both questions proved crucial. Thus, in the early 1990s with hope for individual actions leading to cultural change, I took a cultural production stance, and followed how school practices and societal forces impinged on individuals' becoming members of a campus engineering culture while student engineers did real-world engineering projects for out-of-school clients. I found that engineer identity productions demonstrated learning processes, power relations, local culture, and societal constraints.

Student Engineers Identities as Powered, Gendered, Cultural Form

Students displayed a wide range of ways to be engineers. In student design teams, terms referring to one another as different types of engineer emerged, and these proved a ready discourse (ala Foucault) for recognizing one another's expertise and for chastising unacceptable behavior. These engineer identity terms provided a rich cultural calculus for belonging, or when absent or silent on certain things, also marked not belonging (Tonso, 2006). Students' actions were given meaning using these terms, even as students actively hid behaviors to avoid being admonished by colleagues. Students organized terms into two larger categories: Over-Achievers and Nerds. Clearly, Over-Achievers ruled, since campus elevated them via culturally salient recognition routines. Some among Over-Achievers deployed their power to the detriment of others. For example, an extraordinarily hard-working student might arrive for a meeting just on time and have a higher status teammate miscast him as a slacker (lazy, worthless teammate). Within the categories, only six terms (out of the 36 most-prevalent terms) referred to women. Most were pejorative, except for "sorority woman," which most women student engineers rejected. The absence of terms for women (in the portions of the identity terrain that marked being engineers) made women invisible *as* engineers. Over time as students learned how to be engineers on campus, some students asserted themselves using the terms, and others actively hid some aspects of their selves to avoid being hassled. But being a woman proved impossible to hide, making women student engineers hypervisible *as* women. Ultimately, student social interactions helped produce cultural forms made evident in the identity

terrain, even as extant cultural forms framed insider actions. The campus exemplified a culture filled with tensions about being engineers and doing engineering. In addition, this research highlights cultural production processes which depend on the simultaneity dance between cultural forms and individuals, the give and take of a shaping-and-being-shaped-by process, which I argue proves central to understanding learning in sociocultural contexts. As Eisenhart later wrote: “we can no longer conceive of social groups of people with a culture that is clearly bounded and determined, internally coherent, and uniformly meaningful” (Eisenhart, 2001, p. 17).

Methods that Reinvigorated Studying Cultural Forms

Two strategies used in this study augmented classic ethnographic methods of participant-observation fieldnotes, ethnographic interview, and artifact analysis of student reports and oral presentations (Spradley, 1980). First a paired set of interview questions unpacked the identity terrain. Using a queue-sort strategy (Holland & Skinner, 1987), I initially asked students to list, then define or describe terms they used to refer to one another as engineers, then in a subsequent interview asked them to sort the most prevalent terms into categories that made sense to them and to explain their sorting. Second, coupling this approach with quasi-longitudinal fieldwork of first-, second-, and fourth-year courses (but different students in each course) provided the time dimension central to understanding learning as a process. First-year students knew little about the terms, second-semester sophomores used the terms sparsely, and seniors had a deep understanding, illustrating how student engineers’ expertise extended well beyond the intended curriculum and was learned over time.

Rethinking the Ethical Responsibilities of Researchers

Two issues framed my interpretations of my ethical responsibilities, especially to document variety, conflict, and tension among participants. First, I had been struck by the extent to which researchers, especially in STEM sites of practice, did not comment on gendered findings (Downey, 1993; Nespor, 1994), while others focused on them (Foley, 1990; Hacker, 1989; Holland & Eisenhart, 1990; Traweek, 1988). I endeavored to see genders in all humans, women and men, and to interrogate the diversities of femininities and masculinities, instead of using gender as a demographic binary. Late in the research, one set of interview questions provided a serendipitously rich set of responses. First I asked: “What is it like to be a man here?” and followed with “Would it be different if you were a woman?” Later in the interview, I engaged in a conversation about equality and what it meant on this campus. Responding to the first two questions, students provided a large collection of stories about inequitable circumstances, but later told me “we’re all equal engineers.” Unearthing this illogic illustrated the power of cultural forms to create in the mind’s eye the imagined cultural situation – equality – in spite of considerable empirical evidence to the contrary. Second, I began the research with reservations about research conducted either by social scientists lacking engineering credentials or by engineering educators who lacked social science capabilities. Having worked for 15 years as an engineer allowed me not only to follow students’ engineering talk but also to evaluate it, while my anthropological training helped me investigate how things came to be the way they were, instead of focusing overmuch on only seeing what they were.

How Actor Network Theory Can Challenge the Assemblages of School Accountability and Science Learning

Cory Buxton

A central facet of the Language-Rich Inquiry Science with English Language Learners (LISELL) project is the LISELL professional learning framework. The five components of this framework offer opportunities for participants (teachers, students, parents, and researchers) to position themselves in different ways for varying purposes in distinctive spaces. Among other questions, we have explored how varied identities for learning are made possible for participants based on how they choose to position themselves and how they are positioned by others (i.e., school administrators, other participants, project materials) in the multiple spaces of our work together. We wonder how participants may gain new insights about themselves and about others based on this variable positioning and the identities afforded across these spaces. At the same time, possible identities are constrained by components of the broader networks in which the LISELL professional learning framework is embedded, such as one’s immigration status and English language proficiency. While our full model considers the positioning of teachers, researchers, students and family members, for the purpose of this paper we limit our consideration to the roles that teachers and researchers play across the five components of the professional learning framework, while attending to Eisenhart’s notions of reconceptualized cultural forms.

In the Teacher Professional Learning Institute, the teachers’ initial positioning is as critical evaluators of the LISELL pedagogical model and then as co-developers of classroom content and practices, while the researchers’ initial positioning is as advocates for the pedagogical model and then as co-developers of classroom content and practices. In the Student Biotechnology Academy, the teachers are positioned both as instructors and as Spanish language learners, while the researchers are positioned as facilitators and participant observers. In the professional learning spaces of Grand Rounds classroom observations, the teachers are positioned as

collaborators observing their peers and being observed in turn, while the researchers are positioned as co-observers, learning how project practices are enacted in classrooms. In the Steps to College through Science Bilingual Family Workshops the teachers are positioned as participant observers, Spanish language learners and advocates for their students, while the researchers are positioned as teachers, facilitators, and learners across both organized and impromptu learning experiences. Finally, in the LISELL assessment workshops, teachers are positioned as assessment experts and reflective practitioners, while the researchers are positioned as assessment trainers and as facilitators of reflections on learning from student writing.

Attending to Cultural Forms

Heeding Eisenhart's (2001) call that new ways of thinking may be needed to better understand the diverse entanglements of life in schools without abandoning the notion of culture, the LISELL project has been using Actor Network Theory (or ANT) to identify the resources that are mobilized to establish (or assemble) our professional learning framework (Law, 2004). We view ANT as a powerful bridge between anthropological thinking about culture and the practices of design that may directly influence learning (Latour, 2008). While not a new theory (Callon & Latour, 1981), ANT has remained obscure in educational research (Fenwick & Edwards, 2013). By insisting on the principle of *symmetry* – that human actors and influences should not be privileged over non-human actors such as devices, documents, or spaces – ANT provides a novel lens for understanding how social forces (including knowledge) gather allies (and enemies) to become more and more (or less and less) stable over time (Callon, 1986). This process – *translation* in ANT terminology – can be used to explain how the growth and shrinking, the stabilizing and destabilizing of networks, shape the ways in which social organizations function (e.g., how our professional learning framework, co-constructed by researchers, teachers and other participants, become stabilized and mobilized in some spaces but not in others). Following an ANTish view of how practices are shaped, we looked for *obligatory passage points* (key points through which actors must pass once a network has been stabilized), such as teachers being observed by their peers during grand rounds observations or researchers having their materials critiqued by teachers during the teacher institute. We also attended to *stable mobiles* (elements of a network that stabilized to the point that they can be lifted out of one context and moved to another and still function with the same meaning), such as classroom materials for supporting English learners that are developed by teachers in our project spaces and then taken up by teachers in other schools). When taken together, these ANT concepts provide a different way of examining the moment-to-moment social practices in our LISELL professional learning interactions, as well as the relationships between the disciplining power of social structures such as a school accountability system and the individual and collective agency shaped by LISELL project participation. For example, we have explored how the stable mobile of a superintendent's *non-negotiable practices for instruction* became hybridized with the LISELL pedagogical model to destabilize certain classroom practices that hindered the science learning of ELL students (Buxton, Kayumova & Alexsaht-Snider, 2013).

Reinvigorating Ethnographic Methods

ANT may provide a way to reinvigorate ethnographic methods with its attention – via symmetry – to a range of resources that include people, devices, decisions, documents, organizations, and the connections between all of these. As Eisenhart (2001) noted,

If we are going to trace relationships that stretch out across time and space; and if we are going to analyze activities and cultural forms that are taken up locally but formed or controlled elsewhere, we would seem to need some new ways of doing ethnography, or at least some different methodological priorities. (22).

Thus, in the LISELL project, we held true to certain fundamental principles of ethnography (e.g., participant observation and researcher journaling) while also exploring new approaches to data collection and analysis. For example, by purposefully constructing the five distinct settings and interaction styles in our professional learning framework and inviting different sets of participants from across multiple schools and community contexts into these settings, we have been able to study how the same individuals practice science learning identities situationally. Further, by developing an ANT sensibility toward symmetry, we have traced relationships that involve not only people but non-human actors as well. For example, we were able to consider how the various settings of the professional learning framework influenced the ways that English and Spanish, as well as everyday and academic language, were used as tools to support science learning. Thus, the prominence of Spanish and Spanish-English fusions in the Steps to College family workshops caused teachers to engage differently in the learning process, for example, by listening more and talking less.

Rethinking the Ethical Responsibilities of Researchers

Finally, in the LISELL project we have taken up Eisenhart's challenge that researchers be ethically responsible for painting a balanced and respectful picture of what and whom we study and to grapple with what it means to

create positive change when actors hold divergent ideas in complex contexts. For example, our diverse 9-person research team represents 6 countries of birth and speaks a total of 10 different languages, positioning us quite well to be both alert and sensitive to the implications of cultural and linguistic differences, as well as how those differences influence learning opportunities across the contexts of our professional learning framework. We have tried to balance the voices of various stakeholders (families, students, teachers and researchers) as we think, talk, and sometimes argue together about what makes science learning authentic and worthwhile and how such learning can be fostered for all students within the current accountability structures in our schools. For example, we have had lengthy discussions about the value of outstanding academic achievement if undocumented students are prohibited from attending selective institutions of higher education.

Possibility of Multiplicity: A Spatial Analysis of an Afterschool Participatory Science Media Project as Lived by Youth, Student Teachers, Community Organizations and Researchers

Jrene Rahm

“What are the images that are useful for researchers to “think with” in the contemporary world? Will the images we have relied on for years work or do we need new ones?” (p. 16), a question Margaret Eisenhart (2001) asked over a decade ago and that we build on in this paper. We are reporting on an action research project that entails partnerships among a University and its teacher education program, community organizations, and high schools. That is, we look inside two different afterschool media-science clubs that we ran for two academic school years in partnership with two secondary schools in Montreal, science organizations like the Botanical Garden (summer internship for youth participants), and the University of Montreal (student internships in clubs), inspired by the Fifth Dimension Model (Cole, 2006). Theoretically grounded in sociocultural historical research, each afterschool club is understood as a complex activity system, embedded in a network of culturally heterogeneous activities that are in continuous transformation and movement (Engeström et al., 1999; Sannino et al., 2010). As advocated by the Connected Learning Research Network report (Ito et al., 2013), youth were offered opportunities to pursue media projects on scientific questions and topics they deemed meaningful, under guidance of caring adults and other youth, and as such, supportive of engagement, self-expression and youth voice. The study also responds to issues raised recently in the National Academies Press report, “A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas” (2012), and its emphasis on promoting scientific literacy *for all*, with science literacy being “a democratic ideal worthy of focused attention, significant resources, and continuing effort” (p. 277). In many ways, the project we describe can be seen as “a significant resource” we put in place in two high schools to complement school learning for youth and student teachers, a project driven by high academic goals and standards for all participants and partner organizations.

Two years into the project, however, it became clear that new lenses were needed to “think with” to understand what is happening within each partnership and established system. As Eisenhart contends, we were “pushed by theoretical and social currents to trace cultural forms ‘upward’ and ‘outward’ so as to consider how they are manifested and produced in networks of larger systems.” Yet, simultaneously, we were also “pushed ‘downward’ and ‘inward’ to see how cultural forms become part of individual subjectivities or imaginations” (p. 22). It made us build upon ideas central to multi-sited ethnography in that we grounded our understandings of cultural forms in space-time configurations and a “posited logic of association or connection among sites” (Marcus, 1998, p. 90), both imagined and lived or brought alive in situ. Moving inwards helped us first posit a certain design of the clubs while making possible the study of their transformation within each complex system over time. That is, the science clubs were grounded in research on youths’ participatory cultures (Jenkins et al., 2009), and designed to build upon youths’ cultural on-line practices of creative media productions, pursued through collaborative problem solving or the posting on blogs and podcasts. By situating the imaginary in the literature on new media culture, a youth participatory framing and making of the clubs was possible. At the same time, it left us to wonder about whether our designing for learning worked, and if so, for whom?

Next to methodology, we also needed to mobilize different conceptual tools to understand what was happening and the significance it might have for different learners. We mobilized theories of spatiality which helped us focus on the premise that “how a space is seen, experienced, and understood depends on the positionality of people relative to the space” and their position within society and history (Moje, 2004, p. 15). Accordingly, we could explore in what ways the club was experienced and perceived by our student teachers and how that differed from the manner the researchers, instructors and youth lived the clubs, which in each case was tangled up in complex ways with the larger relational logic of its place. For instance, our student teachers were caught off guard by the orderliness of the club despite its location in an underserved community. They were recognized and positioned as outsiders by the youth in the club, who referred to them as strange. As a consequence, the research and researchers became mediators of worlds, smoothing out a complex interplay of positioning grounded in different spatial histories and current ways of life among student teachers, and youth. The project and its transformation over time also challenged the ethical responsibilities of us as researchers. For

instance, it led us to focus on the sustainability of the clubs over time, beyond the three year funding cycle of the project, a challenge many Fifth Dimension projects have struggled with in the past (Cole, 2006). It also led us to re-envision the project as a dialogical one (Matusoy, 2011). We not only promoted dialogue among different members of the partnerships, but made an effort to continuously explore and focus on multiple voices at stake in the project, those of youth, animators, student teachers, researchers and professionals from the many partnering institutions. It led to a new research imaginary marked by contradictions and complexity, yet making possible an imaginary of the possibilities of multiplicity in terms of learning, identity work and space-time trajectories. In sum, the paper offers one story of an attempt to think in new ways “about what to research and how to do it” (p. 24) that Margaret Eisenhart called for a decade ago.

Learning Science at the Intersections of Race, Class, and Gender: A Longitudinal Study of Girls Negotiating What it Means to “Be Scientific”

Heidi Carlone and Angela Johnson

Historically, pre-adolescent girls’ science learning is framed in multiple ways, including but not limited to: an achievement gap problem; a problem with deficit knowledge and skills; girls’ lack of interest and/or “science identities”; school science’s lack of relevance to girls’ interests, goals, and funds of knowledge; lack of role models and mentors. Many of these framings are consistent with neoliberal, meritocratic views of school, science and learning. They are based on the assumption that addressing the problem will make for a better, more equitable, school science. Yet, we argue that the existing framings of the problem may *not* be the problems girls care about solving, that cause them struggle, or that are integral aspects of their identity work.

Attending to Cultural Forms

Eisenhart (2001) argued about the limitations of the traditional ethnographic strategy of conceptualizing the school or classroom’s culture as a “fairly stable adaptation to the external forces impinging on it” (p. 24), which leaves unexamined the ways external forces get produced in everyday practices, and the ways the classroom can be considered as “a point of entry...to the study of economic, cultural, and political relations shaping the curriculum, teaching, and kids’ experiences” (Eisenhart, 2001, p. 24; citing Nesper, 1997, p. xiii). Following Eisenhart, we study science learning settings, not only for what they teach us about science but, more importantly, for what they teach us about inequity and how power is produced and reproduced.

The study we report on here brought this point front and center. Our original goal was to study the science identity work of ethnically, racially, socioeconomically, and linguistically diverse students across three to four years of school science after experiencing one year of excellent fourth- or fifth-grade science teaching. However, when we focused on identity work practiced by the girls in the study (n=13), entangled in complicated lives in school, the problem that concerned them was how to be a girl in science, with the emphasis on *girl* rather than on *science*. Their identity work in school science was focused on figuring out what kind of girl to be, not on being scientific. Our specific *research questions* are: Within and across four years of school science: (1) What is the nature of girls’ identity work? (2) What femininity practices do they make use of in their identity work? (3) How do these versions of femininity intersect with race and class? (4) How do the girls’ cultural practices impact their identity work as science learners?

Reinvigorating ethnographic methods

This study draws, in part, on classic, ethnographic methods of observation, interview, and artifact collection—what girls did, said, and produced (Spradley, 1980) in school science over three to four years. As Eisenhart (2001) argued, “To be involved directly in the activities of people still seems to be the best method we have for learning about the meaning of things to the people we hope to understand... conventional ethnography, it turns out, is still a good methodological choice in many situations” (p. 25).

We did just that—carefully observing, talking to, and learning from girls over time in their school science settings, with home visits, lunch talks, and observations in other school settings during our final year of data collection. These kind of longitudinal, ethnographic data of students’ science learning and participation over time, though representative of “classic ethnography,” remains rare in the learning sciences literature.

Trained by Eisenhart to study classrooms ethnographically, to examine patterns of activity that give rise to *shared meanings across groups*, we found it a methodological challenge to focus on *individuals’* identity trajectories across time. Further, though we looked for ways individuals creatively leveraged resources from various cultural worlds to craft more satisfying identities for themselves, macro-level structures of race, class, and gender loomed large in each girl’s trajectory and became *more* prominent and relevant over time. So, we used multiracial feminist theory and intersectionality (Archer, et al., 2012; Collins, 2000; Johnson, Brown, Carlone, & Cuevas, 2011; Morris, 2007) as prominent study lenses. Doing so allowed us to consider how race, class, and gender combine in a matrix of oppression (Collins, 2000) and shaped girls’ science educations and identity work, creating “unique obstacles” (Morris, 2007) for those located deeper within the matrix of

oppression. A central assumption of this lens is that race, class, and gender are examined, in combination, as *performances* rather than *traits*: African American girls “practice,” rather than “have” Black femininity. These practices, patterned over time into cultural forms, make an “acceptable” racial class-based, and gendered, identity appear to be “fixed” and/or “natural” (Archer, et al., 2012; Butler, 1990). Identity work, as intersected with larger social structures, is particularly relevant in settings of power, like science. We focused in on girls’ performances of femininity, which allowed us to represent “diversity as well as commonality” of girls’ meaning making and identity work in school science (Eisenhart, 2001, pp. 24-25).

Findings

In fourth grade, most girls made regular bids to be recognized for scientific and/or academic performances; all were “pleasers.” However, girls of color engaged in more identity work to be a “girl in science” in settings with narrower meanings of “science person.” In those settings, girls took up other, more interesting and accessible roles. Nearly all girls were encouraged to “speak up” except: (1) Two confident African American girls from working class backgrounds: One was positioned as a leader who needed to learn to share (Aliyah); the other was positioned as a “loud Black girl” (N’Lisha) (Fordham, 1993); (2) An English language learner from a working class background (Celeste) encountered obstacles in authoring a “competent” science identity in a classroom with narrow definitions of “success.”

By sixth and seventh grade, “nurturing” and “standing up for others” became subversive, not celebrated, practices—especially true of girls of color from poverty/working class backgrounds. Belonging, or minimizing “otherness,” became more prominent across time for nearly all girls. More girls performed as submissive or invisible by 7th grade; most were Latina girls from poverty, or working class backgrounds. “Pleasing adults” was consistent across time for most; but, over time, some girls of color unevenly performed as “resistant” or “rebellious.” Bids for leadership or dominance, though rare in 4th grade, became even rarer in 7th grade. All girls, except for Yazmin and Luisa (two, very academically strong Latina girls from working class backgrounds) changed their practices based on classroom norms.

Discussion

Girls did not need to, nor did most want to, engage in “scientific identity work” to be successful in school science. By 7th grade, they were not asked to be particularly “scientific.” In the few instances when asked to be scientific, most did so with little struggle or resistance, suggesting that they had “learned” school science, though without perhaps learning to be scientific. We wonder: Have many of them (all “good students”) solved the “school science” problem?

All but two working class Latinas changed their practices based on classroom norms. We wonder: If the norms were altered to hold students accountable to more robust science practices, would their gendered/raced/classed-based identity work become less prominent? Would they learn more science? We have some indication that this may be true for two of the White girls who experienced robust school science in sixth grade. We do not know if this would be true of the girls of color because they did not generally experience robust school science in 6th or 7th grades.

African American girls from working class/poverty backgrounds were more likely to perform anti-hegemonic, “stronger” feminine roles (leadership, standing up for others). We attribute this to a resource called *la facultad*, the ability to read a social situation and respond accordingly (Anzaldúa, 1999; Johnson et al., 2011). This is a precarious resource. In sum, our study engaged us in the “‘work of ordering’ the forms of social life of which [our] research activity” became an integral part (Penuel & O’Connor, 2010, p. 280). This process became an “entry-point” (to pick up on Eisenhart’s earlier quote) to a complex web of interconnections, leaving us much to still disentangle.

Significance of Collective Work, Lessons Learned, and Moving Forward

Grounded in widely different K-16 science and engineering learning settings, these ethnographic studies – of the ways in which cultural forms impinge on, and are produced through, social interactions in everyday life – illustrate how nuanced analysis can better shape equity-driven educational processes. Tonso’s engineering students learned to view their world through campus-culture-tinted lenses and to overlook contradictory empirical evidence. Their cultural identity terrain was framed by both campus culture and societal structures, and implied cultural knowledge about power, positioning, and belonging as an engineer. Buxton foregrounds how non-human actors, such as policy documents and lab materials in schools, can be central to the ways cultural forms are practiced and how networks where cultural forms are enacted are continuously being stabilized and destabilized. Rahm’s work in high school settings traced the paths of cultural forms simultaneously moving outward toward broader networks and inward to understand the making of individual identities. Carlone and Johnson’s study illustrated how students’ identity work fit into cultural practices, which were permeated with societal structures, especially gender, race/ethnicity, and social class. Both Tonso’s and Carlone and Johnson’s research studies illustrate how the situations within which identities form in some

learning settings can seem unable to support identities that simultaneously link scientific ways of being with femininities, even as these researchers make evident that much of what students learn falls outside the intended curriculum of the sites, raising prickly questions about studies that assume narrow conceptions of “curriculum.” In contrast, the studies by Buxton and Rahm offer illustrations of how complex the unpacking of everyday practices can be when attempting to design contexts for science learning that attend to multiple and conflicting interwoven discourses and practices (Latour, 2008). Taken together these studies demonstrate that life in these learning settings is both complex and constrained by cultural possibilities that are all too often overlooked in studies of learning; cultural possibilities that essentially constitute the kind of reframing of learning research currently being called for by the learning sciences.

In all four studies, learning was seen as a *process* that played out over time, that encompassed far more than the intended curriculum in the sites studied, and that embodied a wide range of cultural forms and structural forces at play in learning settings. All of these studies have implications for designing learning environments in ways that take equity and inclusion seriously. Buxton, Carlone and Johnson, and Tonso suggest the need to continue to study structural forces to enhance the potential for providing all students with equitable learning opportunities. Carlone and Johnson, and Tonso found that learning settings do not always recognize all who demonstrate capabilities considered important in learning settings, suggesting the limitations of studying persons extracted from context. Rahm and Buxton called for taking youth’s perspectives into account in designing learning settings that matter. These studies also make explicit that learning and becoming are inextricably interconnected, and that cultural forms not only shape learning possibilities, but are tied to the agency of learners and researchers (O’Connor & Penuel, 2010).

Taking an ethnographic approach contributes to research in the learning sciences in a variety of ways. As Tonso suggests, ethnography allows augmenting data-collection and analysis strategies to unearth implicit cultural forms, such as the queue-sort strategy used for unpacking the identity terrain. Ethnography also allows incorporating both spaces (Buxton, Rahm) and non-human actors (Buxton), and the influences of both on identity formation and learning. Because of its commitment to prolonged engagement and persistent observation (Lincoln & Guba, 1985), ethnography makes possible longitudinal and quasi-longitudinal research activities that trace students’ shifting identity work and learning (Carlone & Johnson, Tonso), and provides important complements to current longitudinal studies of cognitive change. Ethnographic researchers may study contexts that are extant (Tonso, Carlone & Johnson) but through interaction with participants in those contexts, may create a positive influence. Ethnographic researchers may also study settings in which they have intentionally positioned participant groups and organized spaces (Buxton, Rahm), to facilitate more (inter)active and participatory ethnographic methods. In either case, these methods may be conducive to research in the learning sciences. The studies clearly speak to the call of “organizing for learning” locally and globally, and as such, entail research that takes us places not always comfortable but that are constitutive of the kind of research that may in turn lead to transformation and action (O’Connor & Allen, 2010).

Finally, all four studies illustrate the importance of considering the ethical responsibilities of researchers in ways that may be informative to the field of the learning sciences. Each of us made a conscious decision to understand the world of our participants from the insiders’ vantage point, often privileging the meaning making of the researched over that of the researcher. Taking diverse voices and perspectives seriously proves essential to creating equitable learning settings. Buxton created intentional spaces for different groups of stakeholders, including often silenced groups such as undocumented parents, to ensure hearing each group’s concerns and needs related to learning and academic success. Carlone and Johnson focused on the identity work done by students and the ways in which some student identities became marginalized and silenced over time, which highlights the responsibilities researchers have to understand learners’ motivations which is yet another critical piece for learning scientists. Rahm illustrates how working dialogically across participant groups, and continuing beyond the limits of funding cycles, can serve to promote life-long learning while also addressing the ethical commitments we struggle with and yet must live up to as researchers. Tonso’s work suggests that making gender (and other circumstances) of all participants visible, and of matching researcher expertise to topics of study, are fundamental to organizing ethical research not only because such research takes all participants (groups) seriously, but also because it makes relevant how all people learn.

Each of us began our research careers under the guidance of Margaret Eisenhart, yet, over time, our research diverged in novel ways in response to central themes taken up in Margaret’s scholarship. As our studies suggest, we have each traveled into arenas that allowed us to develop new lines of thought. Whether complicating notions of engineer identity in ways not foreshadowed in “scientist” identity research (Tonso), layering race/ethnicity and social class with gender (Carlone & Johnson), thinking deeply about how to include a “significant resource” in an after-school program (Rahm), or studying actor networks as a practice of design in a multi-site ethnography (Buxton), each of these studies explicitly responded to challenges articulated by Eisenhart. Because it has been enormously generative for our research, and that of others who similarly owe their impetus to Eisenhart’s scholarship, we honor her work. As a body, this research suggests that the depth of Margaret Eisenhart’s contribution to the learning sciences extends to theorizing, methodological strategies, and

empirical results that provide a unique vantage point on how people learn and become, in science and engineering settings, and beyond.

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