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SCIENCE LEARNING IN EVERYDAY LIFE

Focus on ... Equity and Out of School Learning

Everyday science learning and equity: Mapping the contested terrain

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Out-of-school settings promise to broaden participation in science to groups that are often left out of school-based opportunities (National Research Council [NRC], 2009). Increasing such involvement is premised on the notion that science is intricately tied to "the social, material, and personal well-being" of individuals, groups, and nations (NRC, 2009)—indicators and aspirations that are deeply linked with understandings of equity, justice, and democracy.

We observe, however, that the very conception of equity in the field is a moving target, shifting widely in meaning across contexts and research perspectives—a fact that points both to conceptual and theoretical imprecisions and the politically contested nature of the term. The diverse meanings of equity and their associated implications are reflected in the influential Next Generation Science Standards (NGSS) framework (NRC, 2012), which identifies three common usages of the term. The first definition of equity appeals to "socially enlightened self-interest" and argues that investments must be made in science and engineering education for "underrepresented groups" since "traditional populations" can no longer fully meet the need for skilled STEM labor in the United States (pp. 278). Such a notion of equity views the inclusion of underrepresented groups purely through its instrumental value of maintaining U.S. scientific, technological, military, and economic dominance. Thus, it hinders the possibility of authentically diversifying and changing relationships of power in science and society.

The document also offers a second conceptualization of equity as "fairness" and "equal treatment of all" (pp. 278). This framing, typical of "colorblind" approaches to race, risks reinscribing inequities when it fails to address the historical, social, political, and economic contexts that have differentially afforded or limited opportunities and resources to various groups (Bonilla-Silva, 2001, 2003; Gutiérrez & Jaramillo, 2006).

Finally, the report highlights a characterization of equity as "an expression of social justice [that] calls to remedy the injustices visited on entire groups of American society that in the past have been underserved by their schools and have thereby suffered severely limited prospects of high-prestige careers in science and engineering" (NRC, 2012, pp. 278). The language of social justice is notably invoked in this usage, but injustices are squarely relegated to the past. In addition, the agency of groups who committed such injustices, as well as their accrued material and symbolic resources (Lipsitz, 1998; Spring, 2013), are erased through conspicuously passive language.

While the NGSS framework considers multiple meanings of equity, it is noteworthy that each of these definitions arguably preserves the *status quo* in substantial ways: they simply diversify the actors in certain privileged segments of an otherwise enduringly inequitable and unjust society. As a consensus document, we recognize the need for these frameworks to speak to a broad audience while minimizing overt political stances. This "middle of the road" approach, however, further contributes to dehistoricized and depoliticized meanings of equity.

This same picture of politically diminished and inadequately historicized meanings of equity permeates scholarly work on everyday science learning. For example, in a study of 15 museums and science centers, Feinstein and Meshoulam (2014) showed that conceptualizations of equity varied widely across institutions, although they often amounted to little more than attempts to increase access and diversity in collections, programs, visitors, and staff. Feinstein and Meshoulam showed that these meanings of equity can obscure more substantial differences in institutional logics that profoundly shape hierarchies of power: a *client logic* that emphasized a distinction between the institution and the communities it "served" and a *cooperative logic* that blurred these boundaries and stressed the need to work with multiple communities to develop collective goals and shared ownership of programs. Educators' failure to specify their understanding of terms such as equity, diversity, and access, as the authors demonstrated, has weighty political consequences that are often not addressed or even recognized.

We argue that these dehistoricized and depoliticized meanings of equity, and the accompanying assumptions and goals of equity-oriented research and practice, threaten to render the concept useless. This risk is exasperated by the nearly ubiquitous but also often cursory ways in which discourses of equity are employed. In this essay, therefore, we seek to resuscitate the term. We surface the aforementioned inadequacies, as well as the implicit assumptions they carry, so as to sharpen our conception of equity and to reveal possibilities for future research. In particular, we attend to how different individuals and groups might participate and author themselves in everyday settings of science learning toward more equitable ends. Given space constraints, we do not aim to be comprehensive in our treatment; rather, we elaborate three interrelated sets of issues that are foundational for how equity can be realized through everyday science and, reflexively, for considering the role that science (everyday or otherwise) could play in a more equitable, just, and democratic society.

1 | CONTEXTS OF EVERYDAY SCIENCE LEARNING ARE NOT NEUTRAL

Implicit in many conceptions of equity is the treatment of everyday settings of science practice as neutral and devoid of politics (The Politics of Learning Writing Collective, 2017). Perhaps nowhere is this best illustrated than in the dominant representations of science and scientific practice in designed settings such as museums, aquariums, zoos, gardens, and planetariums. Similar dynamics are evident in STEM-centered hobbies, such as model rocketry and amateur astronomy (Azevedo, 2013). For the most part, these representations portray science as disinterested practice and depict scientific knowledge as neutral and intrinsically benign or worthy (Conner, 2005). Yet these spaces are imbued with implicit and explicit values and goals that are intertwined with conceptions of equity. Notions of equity that undergird these settings stop at the action strategy of increasing access for historically marginalized groups, but shy away from envisioning outcomes that fundamentally reshape inequitable hierarchies of power in STEM and in society. While there are merits to this approach, the focus on access invariably understates deep-seated racialized inequities and injustices in science education and the professional pipeline (McGee & Martin, 2011). As we argue below, however, even these seemingly apolitical spaces are sites of contestation where actors reproduce, challenge, and reimagine equity and hierarchies of power.

The restricted focus on access obscures that settings of everyday science learning do not exist in a vacuum; they emerge within particular political, social, economic, and cultural contexts. From the iconic national science fair that was popularized during the Cold War (Terzian, 2008), or the ongoing interest that the Defense Advanced Research Projects Agency has shown in Makerspaces (DARPA, 2015; Dougherty, 2012; Nordrum, 2016; Vossoughi, Hooper, & Escudé, 2016), formal and informal science and technology education are manifestly political—they privilege ideologies and epistemologies that reproduce hierarchies such as race, class, gender, sexuality, and nationality and limit other ways of seeing or imagining possibilities for equity (Bang & Medin, 2010). But no site can be determined fully by funders or particular interest groups; they are "terrains of contestation" (Gramsci, 1971) that always have fissures and openings for alternative ideological and epistemological perspectives, practices, and struggles. Depoliticized representations of everyday settings, such as Makerspaces and science fairs, work to erase the contestations in these spaces and thus limit conceptions of equity that genuinely include and allow for more ideological and epistemological diversity and are thus more democratic.

2 | NAMING THE DISCOURSES OF EQUITY IN RESEARCH ON EVERYDAY SCIENCE LEARNING

In this section, we name three broad discourses of equity that characterize research on everyday science learning. Our intention is to uncover some of the key assumptions about equity and the "theories of change" prevalent in out-of-school science learning scholarship. No single discourse we list is meant to comprehensively characterize a researcher's perspective, but when partially or totally juxtaposed, discourses capture a broad swath of what has motivated the field's pursuits and the visions of equity that underlie them.

2.1 | Discourses that emphasize increased student achievement and identification with science

Two discourses fall in this category. Discourse (1) states *out-of-school science can be an important bridge for school-based science learning*. As such, the goal for out-of-school science is primarily to improve students' achievement in school science by generating interest, fostering connections to classroom disciplines, and promoting personal relevance. Going beyond the goal of increasing achievement in school-based science, discourse (2) states *out-of-school science offers more authentic and expansive forms of learning in comparison to most school-based science*. From this perspective, school-based science is somewhat artificial and out-of-school science provides opportunities for youngsters to engage in more authentic scientific practices and experience what "real" scientists do. Such engagement and experience is assumed to increase their interest in and understanding of science and translate into gains in classroom performance or pursuits of scientific practice, including professional degrees. Discourses 1 and 2 are prominently reflected in the NRC (2009) report on learning in informal environments. They comprise, in our assessment, the most prevalent perspectives in research on out-of-school science learning.

Discourses 1 and 2 have distinct merits. Discourse 1 provides students access to the "culture of power" (Delpit, 1995) and discourse 2 facilitates students' development of identities as doers of science (Aschbacher, Li, & Roth, 2010). The implicit theory of change in discourses 1 and 2 is that over time the associated activities will lead to a change in the composition of those who engage in formal and informal scientific practices. The narrow focus on access, however, risks silencing other crucial aspects of equity and justice in science and science learning. Additionally, neither discourse addresses or even provides the tools to grapple with the societal structures that lead to the disproportionate underrepresentation of youth of color in science, such as acute inequalities in school learning conditions, employment opportunities, and income and wealth (Anyon, 2005; Lipman, 2011). Even if these structural inequities were addressed and the conditions for an ideal meritocracy were achieved, the focus on access is still intertwined with the ideology of meritocracy. Meritocratic ideology positions "people with insufficient amounts of socially recognized merit […] as undeserving citizens and lesser people" and thus fundamentally "dehumanizes, stigmatizes, and exploits large proportions of the population" for the extreme benefit of a small stratum of society (Nygreen, 2013, p. 175; see also Varenne & McDermott, 1998). Furthermore, these discourses do not provide an adequate lens to critically explore how science is entangled, as others have argued, in (re)producing inequities and injustices through tools used for surveillance, control, and militarism that inordinately affect people of color domestically and globally (Blue, Levine, & Nieusma, 2013; Forman, 1987; Harding, 2006). Discourses 1 and 2, as with any discourse, thus highlight certain problems and solutions, while obscuring others.

2.2 | Discourses that problematize the privileged forms of science

This category is characterized by discourse (3) that states that *out-of-school science can change what is valued in school-based learning and professional contexts*. Discourse 3 has transformed how researchers attend to the multitude of ways in which youngsters make sense of and use science in their everyday contexts. Such investigations have helped expand notions of what constitutes science—who does science and in what contexts—and how they might be productively leveraged in science learning (Calabrese Barton & Tan, 2009, 2010; Roseberry & Warren, 2008). In

doing so, diverse ideologies and epistemologies in everyday science practices have been highlighted to offer radically new conceptions of equity. The theory of change that underlies discourse 3 is that changing what counts as science will make science more pluralistic and responsive to the needs, hopes, and struggles of different communities. However, there is a risk in this perspective of romanticizing the possibility of changing disciplines that are deeply embedded in hierarchical social formations and closely tied to political and economic interests (Harding, 2006; Nader, 1996). Without institutional and structural changes, the practice of professional science is likely to diminish the ideological and epistemological diversity brought by newcomers (Conner, 2005; Philip, Olivares-Pasillas, & Rocha, 2016).

2.3 | Discourses that identify science in justice movements

This category is described by discourse (4) that states that *out-of-school science in justice movements offers new possibilities to understand the relationship between science, equity, and justice*. Rather than starting with science and hoping that it will contribute to equity and justice, this discourse starts by prioritizing community organizing and social movements and seeing how they employ science as one of many tools (e.g., Boyer & Roth, 2006; Jurow, Teeters, Shea, & Van Steenis, 2016). This discourse does not assume that the use of science or the movements themselves have a teleological end that guarantees greater equity and justice. It strives, rather, to better understand the unfolding of collective human activity and the new affordances and constraints that emerge in the process. From this perspective, science does not exist in a necessarily privileged position; the epistemological and ontological assumptions in science also make scientific knowledge partial and incomplete (Harding, 1992). By studying the authentic struggles of groups, as it exists alongside, overlaps, intersects, and conflicts with other human practices, this discourse can reveal the potential of everyday science learning as a part of social change. The theory of change undergirding discourse 4 is that social transformation happens through community organizing and social movements and that science and science learning may have a role to play in the larger enterprise. Discourse 4, therefore, elucidates rich potential to understand the intersection of everyday science and local and global movements for social change, but hazards eclipsing the more proximal goals reflected in discourses 1–3.

We emphasize that each of these discourses are not necessarily coupled to particular meanings of equity. For instance, discourses 1 and 2 often employ each of the meanings of equity outlined by NRC (2012) discussed above. We urge, however, that, as a community of researchers, we begin to more explicitly state the discourses of equity we use, our underlying assumptions and goals of equity, and the theories of change that are fundamental to our equity-oriented work. We contend that while all equity-oriented work is important, not all equity-oriented work is equal. In our assessment, for instance, discourses 1 and 2 can afford new opportunities for individual students from historically marginalized communities, but will not substantially alter the *status quo*. Discourse 4, on the other hand, opens new possibilities for significant societal transformation, but is less likely to directly impact students' achievement in school. We must begin to explicate what we mean by equity and how we work toward it while being candid about its affordances and limitations.

3 | DIVERSE SETTINGS OF EVERYDAY SCIENCE PRACTICE AND POSSIBILITIES FOR NEW MEANINGS AND DISCOURSES OF EQUITY

While research on science learning outside of school has a relatively long history (NRC, 2009), for historical and practical reasons the field has privileged studying learning as it takes place in large institutional settings of museums and science centers, as well as after-school programs. Only recently have researchers begun investigating science learning in such spaces as the home, collective hobby practice, visits to doctors, do-it-yourself venues, neighborhood associations, and community organizing in ways that honor the ideological and epistemological diversity of the participants. This has left the field with a very partial understanding of equity across the full range of out-of-school science practices—

settings that might give rise to new discourses of equity and novel insights into how these sites operate as terrains of contestation with potential for societal transformation.

To illustrate, take the case of hobbies. Hobbies, as we know them today, emerged in the 19th century when industrialism sharply bifurcated work and home environments (Gelber, 1999). Following the rise of capitalism and free-market ideology, "idle" time was deemed to be unproductive and the source of deviant behaviors and ideas. Hobbies emerged as a form of "productive leisure," occupying mind and hands and structuring participation across a range of home-based practices. In doing so, hobbies bridged the worlds of work and home, while becoming sites where race and gender were shaped and contested; they opened a space in the household for men to exercise a domesticated masculinity in a (then) largely female-dominated territory, while at the same time exposing women to business-like values and practices, which were stereotypically masculine (at least for white, middle-class families). Hobbies also appealed equally to the "common man" and the wealthy; both could exercise their skills in ways unbounded by the strictures of work and shared pursuits could ideologically soften the realities of class difference.

While hobbies, like we discussed with science fairs and Makerspaces, might be heavily shaped by dominant social, political, or economic forces, they are never fully determined by them. Hobbies, and practices that started off as hobbies, can become sites that resist or transform dominant norms. Take, for example, two prominent movements among hackers, a subculture of professional and hobbyist coders: the open source movement and e-banditry. The open source movement consciously challenges fundamental principles of profit-driven, capitalist production, albeit in ways that risk re-inscriptions (Barron, 2013). Similarly, hackers involved in "e-bandit" movements, such as Anonymous, explicitly confront what they see as inequities and injustices through new forms of transnational cyberactivism (Wong & Brown, 2013). Like any other human practice, hobbies thus become sites of contestation with the potential to reproduce, challenge, or transform the *status quo*. As sites of everyday STEM learning, these cyber-settings of hacktivism extend discourse 4 into virtual contexts and seed possibilities for new understandings of equity (and their accompanying contradictions).

The point to observe is that hobbies have specific historical origins and developmental trajectories and they unfold in specific political contexts (Atkinson, 2006). As such, issues of equity that characterize hobby practices will be distinct, at some level, from those that characterize other settings of everyday science practice. Even across various STEM-based hobbies, equity issues will likely differ or manifest themselves in different forms. Comparing and contrasting across such settings offers the potential to understand the nuances and span of various meanings of equity in everyday science learning, to evaluate the adequacy of the discourses identified above in representing equity-oriented work in these contexts, and to consider what other lenses would elucidate these settings as sites of contestation.

In all, it is by studying the full space of everyday science practices, across settings and in their full complexity as sites of contestation, that we better understand the possibilities and limitations of everyday science learning for equity and justice.

4 | CONCLUSION

We have offered an invitation for greater clarity when engaging in equity-oriented work in out-of-school science settings. By explicating the discourses and multiple meanings of equity, we emphasized the political nature of everyday science learning and approaches to studying them. We argued that by viewing settings of everyday science learning as sites of contestation, it is possible to highlight the diverse ideological and epistemological perspectives, practices, and struggles that imbue and emerge from these spaces. Attending to underexplored settings of everyday science learning thus offers possibilities for bringing conceptions of equity rooted in marginalized ideologies and epistemologies to the fore and generating new, dynamically evolving, and contextually significant understandings of equity.

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