Summary

This paper draws on ethnographic data to bring equity to the fore within discussions of tinkering and making. Vossoughi, Escudé, Kong & Hooper argue that equity lies in the how of teaching and learning through specific ways of: designing making environments, using pedagogical language, integrating students’ cultural and intellectual histories, and expanding the meanings and purposes of STEM learning. The authors identify and exemplify emergent equity-oriented design principles within the Tinkering Afterschool program—a partnership between the Exploratorium and the Boys and Girls Clubs of San Francisco.

Research Design

This paper draws on ethnographic methods (participant observation, audio-video analysis, photographic documentation, interviews) to offer a preliminary description of teaching and learning in the Tinkering Afterschool Program. Ethnographic research emphasizes the local meanings of educational interactions as defined from the participants’ points of view. The authors also utilize social-interactional analysis of educational discourse to identify key pedagogical practices and shifts in participation over time. Finally, the authors (a research-practice team) draw on collaborative and participatory design research to co-design and co-analyze teaching and learning.

Findings

The authors begin by identifying a central problem within the field of making and tinkering: a lack of explicit engagement with issues of culture and equity. Though the Maker Movement is responding, in part, to narrow, test-centric school curriculum, the question of how best to serve students who bear the brunt of these policies—working class students and students of color—is not often at the center of public conversation. When equity is addressed, they argue, it tends to be framed around “access” to...
high-quality STEM learning & making opportunities, without adequate attention to questions such as: Access to what? For whom? Towards what ends? The authors therefore analyzed the pedagogical “how” of creating learning environments that are deeply responsive to students’ needs and strengths, and rooted in a critical analysis of educational inequity.

The focal setting of this paper, the Exploratorium Tinkering Afterschool Program, collaborates with Boys and Girls Clubs in San Francisco to develop a sustained tinkering curriculum focused on interdisciplinary forms of STEM learning. The program predominantly serves African American, Latino/a and Asian-American youth (K-12) from low-income, historically marginalized communities. Adults, teens and children meet in a workshop setting to design and co-create artifacts such as scribbling machines, shadow plays, and wooden pinball machines. Tinkering is defined as a disposition towards design and making characterized by iteration and playful experimentation. While tinkering activities have particular parameters and goals (ie making a working pinball machine), they are intentionally designed to support multiple pathways and solutions.

The authors identified equity-oriented design principles, which include: building generous learning environments that emphasize shared activity; valuing process and iteration over final products; cultivating play, imagination and creativity; widening definitions of learning, intelligence and science; and grounding learning within purposeful socio-cultural endeavors. This final principle includes making STEM concepts and practices explicit in ways that are organic and meaningful to the activity. Through a series of ethnographic examples, the authors illustrate how:

- A focus on iteration and process can reframe “mistakes” or “failed attempts” as drafts (unsettling dominant definitions of intelligence) as well as the range of ways students took up this value in practice;
- Carefully scaffolded talk amongst students and teachers can deepen sense making;
- Ideas and practices “travel” across settings in ways that both validate students’ everyday experiences and productively expand narrow views of educational “success.”

Finally, in analyzing the ways that students themselves wrestle with dominant definitions of science, the authors argue for opening up these conversations and respecting students’ critiques and questions. They conclude by considering how children’s relationships with science and their own learning may shift with greater recognition of play and the process of making as deeply intellectual activities.

**Theoretical Basis**

The analysis is organized around socio-cultural approaches to learning. This tradition defines learning as shifting and deepening participation over time, a social process that contributes to the practice (and the environment) itself (Rogoff, 2003). The authors draw on this framework to pay close attention to opportunities for young people to experience themselves as knowledgeable participants and contributors to tinkering activities. This involves inquiring into the kinds of development valued and therefore emphasized in a particular setting (Matusov, 1998) as a precursor to looking at how learning unfolds. This approach can help make visible shifts in participation, roles and relationships that may otherwise go under the radar. Socio-cultural perspectives also complement constructionist views by focusing on the social accomplishment of learning and the role of pedagogy or teaching. Finally, this theoretical approach argues for recognizing and leveraging the cultural, linguistic and intellectual resources students bring to the setting (Gutiérrez & Rogoff, 2003). The pedagogical leveraging of everyday experience is all the more pressing for youth whose home and community lives are treated as deficits to be overcome rather than rich resources to draw upon (Gonzalez, et al., 2013).