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Beyond the Binary of Adult Versus Child Centered Learning: Pedagogies of Joint Activity in the Context of Making

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ABSTRACT

This paper argues that the terms through which we interpret and work to develop expansive pedagogical practices are overly constrained by the binary of adult-centered versus child-centered education. Analyzing ethnographic data developed over three years in a making/tinkering afterschool program serving Black, Latinx, and Asian American students (K-5), we explicate and imagine beyond this binary by (1) analyzing key forms of pedagogical talk, listening, and embodied assistance that supported generative forms of learning and relationality and defied categorization as either adult- or child-centered; and (2) theorizing joint activity as a pedagogical practice by historicizing and unmooring the work of critical education from the perpetual negation of Western, adult-centered models, thereby creating distinct grounds for specifying the role of direct assistance and its salience for questions of educational dignity and justice. Taken together, we argue for a more complex view of when and how direct teaching can support meaningful learning, and further delineate the relationships between such teaching and a broader ethos of joint, intergenerational activity.

Western philosophers created an illusory appearance of unity and stability by reducing the flux and heterogeneity of the human and physical worlds into binary and supposedly natural opposites. Order is imposed and maintained by displacing chaos into the lesser of each binary pair. (Flax, 1993, p. 139 in Torres, 2005)

Throughout our work in the field of education, we have witnessed how educators and researchers committed to developing more authentic and just forms of learning often wrestle with what Paradise, Mejía-Arauz, Silva, Dexter, and Rogoff (2014) call the “pendulum swing” between adult-centered and child-centered pedagogies. Describing the ways adults who were socialized into top-down, assembly-line forms of schooling struggled to shift to a more collaborative pedagogical approach, Paradise et al. write that “some first moved from trying to control children to using a children-run model, absenting themselves from interaction and ceding control to the children [Matusov & Rogoff, 2002; Rogoff et al., 2001]” (2014, pp. 146–147).

This swing from adult to child control frequently manifests in hesitation about adult intervention within youth-centered spaces: *a teacher in a classroom organized around critical pedagogy observes as a student-led discussion begins to reproduce dominant gender norms and contemplates whether and how to intervene*. In other cases, the impulse for adults to “absent themselves from interaction” can lead to the interpretation of generative forms of direct teaching as overly adult-centered: *A long-time educator with strong social and intellectual rapport with students offers a*

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dynamic lecture on current political events. Though students appear deeply engaged in the ideas and questions being offered, a newer member of the program staff asks whether the lecture would count as “banking education” (Freire, 1972). Years of work in critical educational contexts have taught us that these tensions are common and that there is a need to further elaborate the role of explicit teaching or direct assistance within critical pedagogies.

More recently, we have witnessed how these pedagogical tensions take shape in settings organized around making and tinkering—activities that blend engineering, technology, and art and typically reflect constructionist orientations to learning (Papert, 1993). In the Tinkering Afterschool Program (TAP), the focal context of this study, youth educators¹ often worked to avoid the didactic forms of teaching prevalent in their own schooling experiences, sometimes questioning whether they should help children use a tool, or whether to offer suggestions for solving a problem. This version of the “pendulum swing” is one we have frequently observed within making and other youth-centered contexts, especially among novice educators. Such grappling is important to educators’ learning and often reflects ethical critiques of rigid, top-down teaching practices. Yet we have also come to see that the terms available for interpreting and developing alternative pedagogical models are overly constrained by a persistent form of binaristic thinking: between adult-centered teaching on the one hand, and student-centered education on the other, also sometimes posed as instructionism versus constructionism. We argue that this binary reduces the “flux and heterogeneity” (Flax, 1993) of human learning, and sets educators up to avoid—or under-design—generative forms of pedagogical assistance and joint activity. This piece is therefore an invitation to those who take a child-centered approach to educational justice to consider how intergenerational learning may better serve their ends (Bang, Faber, Gunneau, Marin, & Soto, 2016).

The sources of knowledge for the arguments we develop here are multi-layered. They begin with our own life histories both as children and caregivers within families with roots in the Global South whose everyday cultural and pedagogical practices emerge from an ethos of collectivity and intergenerational activity. They include a history of practice and collaboration with educators of color who approach pedagogical design as artistic activity (Bang et al., 2016; Espinoza, 2008; Tejada, 2008), as seen in our close analysis of pedagogy in TAP and our own experiences organizing learning with and for students within a range of settings. They also build from our deep engagement and mentorship within a robust history of critical and socio-cultural scholarship that has theorized learning beyond the binary of adult versus child-centered education (e.g., Dewey, 1938; Freire & Macedo, 1995; Gutiérrez, Rymes, & Larson, 1995; Kirshner, 2008; Nasir et al., 2006; Rogoff, 2003; Tejada & Espinoza, 2003; Vygotsky, 1978).

Drawing from these multiple histories of thought, this paper works to explicate and imagine beyond binaristic pedagogical models in two ways. First, we offer empirical analyses that assert the need to foreground pedagogical design and practice as primary objects of study within research on making/tinkering environments. In prior work, we argued that in order for the maker movement to advance equity in substantive ways, close attention to the pedagogies that shape making environments is crucial (Vossoughi, Hooper, & Escudé, 2016). We also stated that the tendency to foreground individual learning processes:

suggests that pedagogical structures were either absent or minimal or resulted from a methodological and conceptual decision to minimize explicit attention to pedagogy, even if it was a significant part of the learning process. When educators are mentioned, they are consistently framed as “facilitators,” “guides,” or “coaches,” a discourse that tends to treat the word “teacher” and the practices associated with being a teacher as inherently didactic or problematic. (Vossoughi et al., 2016, p. 220)

Taking up our own charge, this paper analyzes a large range of examples of pedagogical talk, listening and observation, and embodied forms of assistance, working to trouble binaristic

¹The TAP pedagogical team was comprised of both adult and youth educators. Youth educators ranged in age from 14-20, and were either teen staff at the partnering museum or the Boys and Girls Club, or alumni of the TAP program itself.

thinking within research on making by deepening our understandings of pedagogical structures that defy categorization as either adult- or child-centered.

Second, we work to theorize joint activity as a pedagogical practice by historicizing and unmooring the work of critical education from a perpetual negation of Western, adult-centered models (Lyons, 2000; Mignolo, 2009; Warren, Vossoughi, Roseberry, Bang, & Taylor, 2020), thereby creating distinct grounds for specifying the role of direct assistance within a broader pedagogical imaginary. Here we are primarily concerned with analyzing *when* and *how* direct teaching (e.g., explanations of concepts, instructional narratives, overt and sustained guidance) supports generative learning, particularly when embedded within an ethos of shared, intergenerational activity (Rogoff, 1994). In line with our understanding of educational dignity as the “multifaceted sense of a person’s value generated via substantive learning experiences that recognize and cultivate one’s mind, humanity and creative potential” (Espinoza, Vossoughi, Rose, & Poza, 2020), we conceptualize generative learning as a socially mediated experience that expands participants’ relationships with the domain or practice, with one another, and with their own value as thinkers.

This orientation leads us to pay close attention to moments of direct teaching that create conditions for shared thinking and convey a sense of intellectual respect (Rose, 2014), defined here as taking students’ ideas, questions, and activity seriously. The role of pedagogical talk and interaction in substantiating a sense of intellectual respect takes on particular political and developmental significance in light of the systemic injustices experienced by students marginalized along the lines of race, class, gender, sexuality, and ability, particularly within the context of schooling (Lee, 2003; McKinney de Royston, Madkins, Givens, & Nasir, 2020; Langer-Osuna & Nasir, 2016). It also reminds us that child-centered models are often entangled with White, middle-class efforts to *appear* democratic through practices such as veiled directives, and concomitant deficit views of direct instruction within communities of color (Delpit, 1988; Rogoff, personal communication, 06/27/2020). Our view of educational justice therefore requires attention to the relationships between macro and micro scales of activity (Bang & Vossoughi, 2016; Davis, Vossoughi, & Smith, 2020), and sensitizes us to the ways overlooking the generative role of direct teaching can reproduce racialized harm and constrain opportunities for learning.

Our analysis argues the need for researchers, teachers and teacher-educators to expand our perceptions of direct teaching, toward deeper attunement to *when* and *how* it is generative or constraining, and *why* (as tied to what kinds of valued experiences). Ascertaining the situated generativity of direct forms of assistance requires attuning to relationships between the means and ends of teaching. In this vein, we argue that pedagogical practices that can appear didactic (such as explanation) may, through a deeper understanding of their intellectual and relational qualities, function in ways that are dialogic and developmentally generative (Espinoza, 2008; Tejada & Espinoza, 2003). Similarly, practices that are often valued within child-centered models (such as listening closely to children’s ideas) can be important in part because they give life to more productive forms of teaching. This is not an argument for the categorical generativity of direct teaching; nor do we assume that pedagogies of joint activity are exempt from the power dynamics present in all learning interactions. Rather, we argue for a more complex view of when and how direct teaching can support meaningful learning and relationality, and aim to further trace the specific connections between such teaching and a broader ethos of joint activity.

In what follows, we describe the research on pedagogies of joint activity as tied to the role of educators. This section also further elucidates the problem of binaristic thinking within recent literature on making. We then describe our methodological approach to analyzing pedagogical practice within TAP. Though our findings have implications for the research and design of teaching more broadly, our inquiry focuses on pedagogical practice in making environments, many of which define themselves as youth-centered.

Pedagogies of joint activity

While the growth of maker spaces and the tensions they resurface between constructionist and instructionist models serve as one motivation for our research, critiques of adult versus child-centered binaries have a long history. Educational theorists such as Dewey (1934), Freire (1972), and Vygotsky (1978) sought, each in their own ways, to challenge authoritarian educational models through a re-imagination rather than a rejection of the role of the educator, and a shift toward shared activity and dialogue across adults, youth, and children. Our readings of their work alongside the many scholars who have taken up, debated, and extended their projects offer a view into various efforts to think beyond pedagogical binaries. In this section, we consider how joint activity has been theorized within critical and socio-cultural theories, identify divergences between these theorizations and the discourses common within the research and practice of making/tinkering, and argue the need for greater analytic attention to the role of direct assistance in pedagogies of joint activity. We use “joint activity” as an umbrella term to refer to lifeways that conceptualize teaching and learning beyond adult-versus child-centered binaries by centering intergenerational relations, dialogue, apprenticeship, and collaboration. Where we discuss particular contributions, we try to use the language that the authors themselves employed.

As a pedagogical model, joint activity privileges the dynamic and mutual learning that can emerge through intergenerational collaboration (Wertsch, 1998; Rogoff, 2003), where children work alongside adults to carry out activities “with purposes connected explicitly with the history and current practices of the community” (Rogoff, 1994, p. 211). Theorists of joint activity view *guided participation* as a way out of the adult transmission versus child acquisition frame (Rogoff & Gardner, 1984; 1990) and consider “guidance and learning as a united collaborative process” (Matusov, 1998, p. 332). This sense of mutuality and co-presence is importantly distinct from the idea of a “middle-point between control and withdrawal” (Matusov, 1998, p. 334). Much of this research is therefore critical of the ways adult- versus child-centered frameworks constrain our understandings of learning in the context of family and community, particularly outside of Western paradigms and colonial imaginings (Bang et al., 2016; Rogoff, 1994). Instead, learning is understood as the transformation of participation over time (Rogoff, 2003), a process through which the individual, their relationship to the environment, and the environment itself are transformed (Cole, 1985; Gutiérrez, 2008).

Connecting pedagogies of joint activity with questions of culture and equity, Rogoff, Callanan, Gutiérrez, and Erickson (2016) argue that “these fluid and flexible participation structures create more openings for a range of practices, including valued everyday and cultural practices, often not taken up in schools” (p. 381). Gutiérrez’ history of work on the third space (Gutiérrez et al., 1995; Gutiérrez, 2008) further substantiates this claim, where tensions between official and unofficial discourses, as well as academic and everyday ways of knowing (often viewed in deficit terms for minoritized youth), are leveraged toward “transcendent scripts” (Gutiérrez et al., 1995) and expansive learning for all participants. Similarly, Engeström and Sannino (2010) argue that both acquisition and participation models of learning “have little to say about transformation and the creation of culture” (p. 2). Their notion of *expansive learning* focuses instead on contexts where learners are “involved in constructing and implementing a radically new, wider and more complex object and concept for their activity” (p. 2). This attention to the expanding ends of learning contrasts with research on cognitive apprenticeships (Collins, Brown, & Newman, 1989), which emphasizes modeling and scaffolding students into expert practice, but tends to treat the domain itself as settled (Bang, Warren, Rosebery, & Medin, 2012). These theoretical distinctions are important for interpreting the role of direct assistance, in this case by considering whether teaching is aimed at fixed or expanding goals of learning.

The role of educators

Reconceptualizing learning beyond the binaries of adult/child control also requires redefining the role of educators. Whereas adult-centered models treat teachers as active and students as passive receptacles of knowledge (Freire, 1972), and child-centered approaches typically treat adults as passive and students as active (Zavala, 2018; hence a preference for collaboration among youth but not necessarily with adults), pedagogies of joint activity treat adults, children, and youth as active co-participants in knowing and learning (Rogoff, 1994). Freire (1972) therefore urged teachers to see themselves as teacher-students and to see students as student-teachers, a reimagination of roles that can support dialogic meaning making. Responding to what he saw as a misinterpretation of his ideas toward teacher passivity, Freire frequently distinguished between teachers as authoritarian figures and teachers as ethically and politically responsible for organizing the educational process:

What one cannot do in trying to divest of authoritarianism is relinquish one's authority as teacher... The facilitator who claims that "since I respect students I cannot be directive"... denies himself or herself the pedagogical, political, epistemological task of assuming the role of a subject of that directive practice. (Freire & Macedo, 1995, p. 2)

This perspective guides our inquiry into the situated meanings of teaching, and leads us to question critiques of power that relinquish pedagogical responsibility. A key issue, in our view, is whether teachers' "directive practice" is guided by a logic of control or by an ethic of social and intellectual nourishment. Though terms such as "teacher" and "facilitator" have local and dynamic meanings that may not always align with Freire's characterization, versions of the phrase "I'm not a teacher, I'm just a facilitator" are so common within youth-centered contexts that the distinction offers an important view into how pedagogical binaries take shape.

Such binaries are common within the field of making, with particular consequences for questions of educational justice. For example, analyzing the dynamics between classroom teachers and "tinkers" (the term used for maker facilitators in their context), Campos, Soster, and Blikstein (2019) "*Sorry, I Was in Teacher Mode Today*" illustrates how tinkers consistently distinguished their activity from teaching, relegating the use of authority to their partner teachers. As one tinker stated, "I think I should have less of an emphasis on trying to teach them how stuff works and just get them kind of playing with stuff and figure out how it works as you're actually playing with it, you know?" (p. 6). Campos et al. found that because tinkers paid less attention to classroom structures and ways of being, they often ended up exerting power through overly prescribed activities. Some also concluded that making works best in higher income schools and communities. These findings align with our observation that hands-off pedagogical approaches tend to reinscribe deficit ideologies (blaming students for ill-structured activities), and often lead to the reassertion of power through overly prescribed tasks. As Blikstein and Worsley (2015) wrote:

Novices coming into a makerlab need considerable amount of onboarding and facilitation... When such facilitation was absent, these students (who are disproportionately females and minorities) felt lost and frustrated, and reported even lower self-esteem than before coming into the lab... the opposite happened when those novice students were gracefully introduced to the space and tools. (p. 71)

Another example comes from a thoughtful self-study of one teacher's efforts to implement a makerspace in a high school serving students she described as marginalized. Cantelon (2018) writes of her initial struggles with the outcomes of a total free-choice approach, which led to projects she considered to be less intellectually challenging. Cantelon later wrote: "I began to see the problem not so much as a dichotomy between teacher-control vs student autonomy, but rather helping students transition from a teacher-controlled environment to a more autonomous learning structure" (p. 58). Cantelon eventually moved toward a "scaffolding autonomy" approach, while reflecting on why she had mistrusted her own pedagogical expertise within the

context of developing a makerspace. We suggest that the often-romanticized language used to describe student autonomy in the literature on making (e.g., phrases like “self-directed” or “independent” learning are prevalent [Vossoughi & Bevan, 2014]), coupled with insufficient attention to pedagogical structures, may contribute to a seasoned teacher asking, “Do I challenge the students?” (Cantelon, 2018, p. 47). This question further illustrates how binaristic logics can reproduce deficit ideologies by functionally treating what students can do on their own as the extent of their capabilities. Vygotsky (1978) in particular was critical of “placing all educational stress on the spontaneous aspects of the child’s activity” (Piaget, 1973, p. 11) in ways that position teacher’s mediation as necessarily constraining. We therefore see a correlation between teacher passivity and the assumption that agentic student activity is autonomous rather than interdependent (Davis et al., 2020; Fryberg & Markus, 2003; Matusov, 1998).

Here, it is important to express that we have also encountered many making spaces where thoughtful, nuanced pedagogy is enacted, but where educators and/or researchers’ narratives *about* their practice rely on child-centered language that glosses over its intentionality and complexity (Vossoughi & Shea, 2019). Researchers of joint activity similarly note that “in many middle-class, Western communities... [caregivers] downplay their own involvement, help, and guidance [Ochs and Schieffelin, 1984; Ochs, 1992], reframing their joint activity with the child as solely the child’s accomplishment” (Matusov, 1998, p. 341). We have witnessed a related though inverse tendency in our professional development work, where videos depicting rich instances of joint activity across adults and children are read by some as “taking over for kids,” often based on surface features such as whose hands are on the tools in a given moment. Though some youth-centered models reproduce the tensions of hands-off pedagogy, others use the term “youth-centered” to delineate the prioritization of youth needs and lived experiences through practices of radical care (Baldrige, Beck, Medina, & Reeves, 2017), well-structured supports and intentional guidance (Kirshner, 2008). Ozacar, Hladik, Shanahan, and Sengupta (2020), for example, found that while parents centered their children’s goals in a museum-based computing exhibit, they were heavily involved in guiding the interaction. Less generative interactions were not a result of parental involvement, but emerged when children’s goals were decentered.

Recent research has paid greater attention to the professional development of maker-educators in schools (e.g., Blikstein & Valente, 2019; Jin, 2019). Yet this work largely focuses on curriculum and activity design, with less attention to the *how* of pedagogical practice. Where these structures are elucidated (e.g., Barajas-López & Bang, 2018; Roque, 2016; Sheridan et al., 2014; Soep & Chávez, 2005) key resources are generated for pedagogical design and practice. As Godhe, Lilja, and Selwyn (2019) argue: School-based making activities need to better emphasize the importance of teachers and acts of intentional teaching. Despite the rhetoric, learning activities are rarely spontaneous (p. 8). Our work pushes for close attention to what “acts of intentional teaching” look like within making settings.

Knowing and relating

Similar to the distinction between teachers and facilitators, the question of when to withhold knowledge in the service of student learning is common within making and youth-centered contexts. Like Freire, Dewey’s later writings contest interpretations of his work that encourage such withholding, arguing that “the mature person, to put it in moral terms, has no right to withhold from the young on given occasions whatever capacity for sympathetic understanding his own experience has given him” (1938, p. 38). As our analysis takes up, the tension between withholding and hyper-mediating (offering too much or non-strategic forms of assistance [Gutiérrez & Stone, 2002]) represents one of the residual binaries that flow from adult- versus child-centered frames, and calls for greater empirical specification.

Ascertaining the strengths and limitations of various pedagogical models also requires explicating the forms of relationality, knowing and development they value (Matusov, 1998). Rogoff et al. (2016) found that learning in informal settings (with intentional but not overly rigid structures) is more conceptual than in assembly-line instruction, “where superficial knowledge is often sufficient to get by” (p. 389). Studies of learning in family and community settings have also found that young people are positioned to understand phenomena in order to contribute to collective endeavors, often coming up with new and improved ways of doing things (Nasir, 2008). Across these models, “knowledge and skills are deeply relational with a high positive social value and thus are bound up in meaningful relationships with the people in the teaching role” (Rogoff et al., 2016, p. 380). Connecting an ethic of relationality with Indigenous resurgence, Barajas-López and Bang (2018, p. 17) argue that Indigenous making and sharing “enables continual renewal of family and community to assert contemporary presences and living Indigenous nature-culture relations.” Here intergenerational relations are both the means and ends of learning (see also DiGiacomo & Gutiérrez, 2016); and elders play a key role in modeling the ways of knowing and nature-culture relations valued by communities (Barajas-López & Bang, 2018; Marin, 2020). The consequential role of adult guidance for projects of resurgence in the face of colonial erasure and assimilative demands sheds distinct light on the ways hands-off, child-centered approaches can reproduce the ontological entitlements of Whiteness.

Beyond binaristic ontologies of teaching

Across the historical and contemporary literature discussed above, scholars typically eschew the idea that pedagogies of joint activity are a “balance” or “middle-ground” between control and freedom, and argue instead for understanding movement beyond the binary as a distinct direction (Gutiérrez et al., 1995; Rogoff, 1994, 1990). As Kohn (1993) argues, “the sensible alternative to two extremes may not be an intermediate point but a different way of thinking about the issue all together. The interesting question, for example, is not how much adults should limit the power of children to make decisions, but how they should get involved” (p. 15).

The shift from (1) a rejection of adult-centered models to (2) a hands-off approach to (3) an alternate path that accounts for the limits of both 1 and 2 is not an uncommon trajectory among progressive educators (Paradise et al., 2014). Indeed, child-centered language is frequently used as a way to “pull” new teachers away from default, adult-centered modalities. Yet, the language of dialectics, or even the idea of creating a different path beyond two extremes, also risks erasure in so far as it occludes the genealogy of joint activity as a set of approaches to human learning which often preceded—rather than emerged in response to—Western models of schooling (Bang et al., 2016). Here intergenerational configurations for living offer/ed multiple forms of joint activity in ways that consider roles, relationships and accountabilities (Marin, 2020). The term *elder*, for example, and the forms of respect afforded elders within many communities of color, makes visible how narrow interpretations of adult leadership can overlook the histories and value systems undergirding intergenerational relations across cultural contexts, and the crucial role of adult allies in disrupting educational injustice through community-based education (Baldridge et al., 2017). Similarly, Rogoff and colleagues’ *LOPI* (*Learning by Observing and Pitching in*) model was developed through deep study of long-standing, Indigenous forms of apprenticeship in the Americas. Here, “adults may assume that children eventually join ongoing community activities rather than trying to center activities around children” (Matusov, 1998, p. 334). The role of elders also reminds us that joint activity does not only emerge between children and adults but also within and among young people and adults of different ages and forms of experience within community.

These histories underscore the ways “balance” or “middle-ground” resolutions to pedagogical binaries minimize what are distinct educational paradigms. Key here are the ways critical and

youth-centered pedagogies often take adult-child relations under capitalist and colonial systems, and the problem of adult supremacy in particular, as the ontological grounds or starting point that must be continuously negated through a backgrounding of adults. This point does not deny the fact that many youth-centered contexts work to negate adult power because of young people's legitimate experiences with adult supremacy through practices such as "making decisions without the input of youth (Hogan, 2002), creating only token opportunities for youth participation (O'Donoghue, Kirshner, & McLaughlin, 2002), or promoting punitive policies toward minors (Males, 1996)" (Kirshner, 2008, p. 64). While constraining adult roles and elevating youth leadership therefore enact important critiques of adultism (Kirshner, 2008, p. 64), such responses often do not trouble age segregation "as normative or commonsensical" and are "not always restorative of intergenerational relations in everyday activity" (Bang et al., 2016, p. 10). Thus, when student-centered models sidestep the consequential role of pedagogical design and mediation (Zavala, 2018) and the reimagination of adult-youth relationships, they can replay—though in critical terms—a kind of individualized, pull-yourself-up-by-your-bootstraps pedagogy that belies liberatory goals. This version of the pendulum swing also constrains the space for adults and young people to learn how to meaningfully coordinate and think together (Marin, 2020). Distinct models of human learning, particularly within Black, Indigenous, migrant, and immigrant communities (Paris & Alim, 2017), can therefore inform the design of learning environments in ways that support the healthful repair of intergenerational relations toward the kinds of co-presence and ethical responsibilities necessary for just forms of life (Bang et al., 2016; Booker & Goldman, 2016).

We posit that such a shift requires attunement to the emergence of residual binaries as occasions for greater inquiry and specificity. Residual binaries carry the trace of adult-child centered binaries and flatten practices that are highly contingent on local values, as well as the relational histories among participants (Vossoughi, Jackson, Chen, Roldan, & Escudé, 2020). They often include:

Dialogue	Versus	Telling (or "direct instruction")
Active engagement	Versus	Student listening
Withholding assistance	Versus	Hyper-mediating
Open-ended	Versus	Scripted activities
Material exploration	Versus	Explanation and skill-building

This list is representative rather than exhaustive, and the final two may be more prevalent within making or inquiry-based STEM education. The crucial point is that either-or thinking constrains pedagogical imagination and practice (Dewey, 1938). If students listening to a lecture automatically signifies that they are not actively engaged, it becomes difficult to distinguish between lecture as "banking" or information delivery, and forms of pedagogical mediation or storytelling that stoke the mind, opening up new ideas, relations and questions (Barajas-López & Bang, 2018; Espinoza, 2008; Gutiérrez, 2008; Tejada, 2008; Zavala, 2018). Similarly, if teachers withhold knowledge and support for fear of hyper-mediating, they may miss opportunities to provide generative forms of assistance, and risk withholding in ways that can be experienced as educational neglect. As Rose (1999) argues, "to move into authentic practice does not rule out along the way a host of traditional teacherly devices ... for some, full participation may require it; otherwise one gets a shadow involvement never leading to true participation and competence" (p. 154). Treating material exploration and didactic explanation, or scripted and open-ended activities, as mutually exclusive also overlooks the dynamic ways these modalities can work together in design and practice. Such binaries invite oversimplified readings of pedagogical talk and action.

Tejada and Espinoza (2003) define developmentally generative pedagogical speech events that are misread as didactic as "dialogue1," highlighting the dialogical qualities of what may be interpreted as monologic talk. Dialogue1 is defined as:

recurring moments in a relationship with a “more expert other”—e.g., a teacher, peer, parent, or sibling—in which communication and epistemic responsibility appear asymmetrical but may actually be developmental. Essentially, misperceptions of dialogue¹ as monologic or authoritarian stem from ahistorical (with respect to relations between participants) and simplistically quantitative (counting and timing turns at talk without ethnographic consideration of participants relative location within an activity) analyses of human interaction. Monologic misperceptions of dialogue¹ dismiss both the active role of listeners in the speech act [Fiumara, 1990], the ethical/pedagogical intentions of speakers [Rommteit, 1991a, 2003], and the cultural power of the aesthetics of talk-in-interaction [Bauman, 1990; Briggs, 1988]. (Espinoza, 2008)

Guided by this framework, our analysis works to expand the interpretive tools and vocabularies with which we analyze teaching by focusing on *when* and *how* direct assistance can be generative, particularly when embedded in an ethos of joint activity. Rogoff (1994) argues that newcomers to the Community of Learners model often had to learn to see the subtle but consequential forms of structure present within what may appear to be child-centered learning environments (see also Rogoff et al., 2001). Looking from another angle, this paper elucidates the subtle but consequential openings and forms of dialogue present within what may appear to be adult-centered.

Setting and methodology

TAP was a partnership between a science museum and Boys & Girls Clubs serving working-class communities of color in a large, West Coast city. Program participants were primarily children (K-5) and young adult educators (ages 14–20), many of whom attended the clubs themselves as children. The focal club highlighted in this paper served African American, Mexican, Central American, Chinese, Filipina/o/x, Vietnamese and multi-racial/ethnic children and families. Meg (TAP program director, lead educator and teaching artist) is Argentine and White, Walter (lead educator and teaching artist) is Black, and Shirin (lead researcher and co-educator) is Iranian. All other program staff and members of the research team were also from immigrant and/or diasporic backgrounds.

TAP privileged the relational dimensions of learning and worked to ground scientific and artistic practices in the developmentally-rich contexts of play and everyday activity (Vossoughi, Escudé, Kong, & Hooper, 2013). Each program session began with a group circle time that introduced the day’s activity (e.g., scribbling machines, musical instruments, circuit boards) and served as a space for community building. During circle time, the pedagogical team typically asked children an opening question that served as a way to continue building community, walked students through how to get started on their projects, and shared a range of models and pathways into the activity. These models were often made by educators, who positioned themselves as fellow artists and makers. The opening circle was followed by workshop time, where participants worked in pairs or ensembles on their projects. Educators circled the room to offer support, worked with particular students for an extended time, and sometimes made their own projects side by side with children.

From 2011 to 2014, Shirin worked with Meg to develop a corpus of ethnographic data, including 70 hours of video, 30 extensive field notes, and 15 interviews with focal participants. Vossoughi and Escudé (2016) offer a more extensive discussion of the forms of partnering and co-design they developed together, including coauthored field notes, collective video analysis sessions, and structures that drew on real-time research to support ongoing design and PD. Ethnographic approaches are particularly appropriate for ascertaining the textures and meanings of pedagogical action (Cazden, 2001; Erickson, 1986; McDermott & Raley, 2011), and allowed us to contextualize salient interactions in the history of routine pedagogical practices within the setting. Our analysis focuses on data that offered rich information on the nature and quality of pedagogy within TAP.

Here, it is important to note that other papers published from this project extensively analyzed the forms of embodied (Vossoughi et al., 2020) and agentic learning (Davis et al., 2020) that emerged within TAP over time. These papers present findings developed through coding and analytic processes that looked closely at children's acts of self-determination and learning, as well as trajectories of embodied learning over various time scales. Having reported on the forms of thinking and learning that emerged within TAP, and the ways TAP educators continuously reflected on the complexities of their practice (Vossoughi et al., in press), this paper privileges the routine pedagogical practices that characterized the interactional life of the setting. Our decision to focus on pedagogy is also guided by our sense that the making literature's tendency to delimit analysis of pedagogy may emerge from the need to prioritize evidence of learning when writing about a makerspace, activity or tool. To illuminate connections between teaching and learning processes, we interweave our analysis with references to this larger body of work, provide information about how children responded to particular pedagogical practices, and offer examples that show joint meaning-making between adults and children. However, our focus in this paper is on analyzing the pedagogical practices themselves—and the values embedded and expressed therein—within a setting that has been empirically established as a robust context for learning. This approach is aimed at providing resources both for teacher learning and research on teaching, imperatives we revisit throughout our analysis.

To surface and analyze the routine pedagogical practices that characterized TAP, we spent several months developing analytic memos on key activities (revisited through video and fieldnotes) identified by educators and researchers as indicative of a heterogeneous range of pedagogical actions. Beginning with the construction of in-depth analytic memos also allowed members of the research team who had not collected first-hand observational data to gain familiarity with the space and participants. Our initial analysis asked: (1) What were the routine pedagogical practices within TAP? (2) When and how did these practices support generative experiences with making, and with one another? We used these interpretive documents to refine the existing coding scheme, which had been co-developed by Shirin and Meg, and to detail the range and frequencies of pedagogical action in TAP (see [Appendix A](#)). We then coded all existing fieldnotes, memos, and interview data using Nvivo software. Each data source was reviewed by two members of the team to clarify and confirm our understandings and applications of particular codes. These discussions would often lead team members to revise their initial coding, or propose new sub-codes. The majority of fieldnotes and memos also included close analysis of video, which allowed for detailed accounts of pedagogical interaction and attention to how children responded in the moment and over time.

Through these analytic processes, we noticed that various forms of direct assistance often mediated rich moments of interaction not easily categorized as adult or child-centered. This insight was also supported by the frequent cross-coding of direct forms of assistance with *educational dignity*, *joint activity*, *fluidity of expert/novice roles*, and *epistemic heterogeneity*. For example, we found that when educators explicitly offered students suggestions for solving a problem or approaching a task, they often named multiple possibilities, which we labeled as “offering suggestions” + “multiple pathways” ($n = 71$). Such layered practices offer a way out of the aforementioned pendulum swing (Paradise et al., 2014). By providing direct guidance while introducing multiple possibilities, educators could invite a pluralistic disposition toward solutions and techniques, and often gained a better understanding of the idea students were working on through the path they ultimately pursued, which could be overrun by a singular directive. To the questions posed above, we therefore added the following: (3) How are direct forms of assistance used in TAP? What are the relationships between such direct assistance and joint activity? With this question in mind, we reviewed our coded data and focused our analysis on educators' pedagogical talk, listening and observation, and embodied assistance. The decision to include listening and embodied assistance was guided by our observation that these three practices frequently co-

Table 1. Key codes.

Broader category	Sub-code(s)	# of instances
Pedagogical talk	Explanation	253
Pedagogical talk	Emphasizing process	306
Listening and observation	Making efforts to understand children's ideas and goals (e.g., <i>questioning</i> , <i>re-voicing</i>)	243
Embodied assistance	I do one part, you do the other	82

occurred, and the kinds of listening and embodied actions we observed often involved educators serving as active mediators of activity. Our prior work also identified embodied assistance as a subtle yet consequential site of socio-political action (e.g., teachers' embodied movements can convey assumptions about students' intelligence and capabilities [Vossoughi et al., in press]). Our research team members then took on specific sub-codes for deeper secondary analysis (Table 1).

We focused on *explanation* and *emphasizing process* based on recommendations from Meg, who often experienced a disconnect between discourses of child-centered learning within the world of making and what she knew to be generative forms of intentional teaching within TAP. We included *observation* and *making efforts to understand children's ideas and goals* in order to study how practices that might be valued within child-centered models functioned within a setting that treated joint activity as a core principle. Further, *explanation*, *emphasizing process* and *making efforts to understand kids' ideas and goals* were the most frequently occurring pedagogical practices within the setting. Our previous analyses confirmed that these practices directly shaped the ethos of joint activity within TAP (we documented, for example, how children who participated regularly in TAP came to support their peers by first making efforts to understand the goal or idea they were working on). Within the broader category of *embodied assistance*, we decided to focus on *I do one part, you do the other* due to its central connection to joint activity. Our analysis also notes how direct assistance was used to initiate and sustain *I do one part, you do the other*.

Using top-down coding and micro-ethnographic analysis (Erickson, 2004), we looked closely at every instance of these codes with our research questions in mind. This led us to identify key kinds (or sub-codes) of each practice (e.g., various ways of emphasizing process or attuning to children's ideas and goals). Each of the analytic sections below describes these sub-codes in order to elucidate the pedagogical practice and to analyze the specific relationships between direct assistance and joint activity. For example, we studied the nuances embedded within practices like *explanation* by asking: What kinds of explanations? When and how are they generative and/or constraining? If and how do students take up the meanings shared through explanations further downstream? Studying patterns of typicality and atypicality (Erickson, 1986) within our sub-codes and seeking out discrepant cases helped bring further complexity to our discussion of teaching as a deeply situated and responsive activity (Philip et al., 2019). Contrasting cases (less productive *explanations*, moments when *emphasizing process* or initiating *I do one part you do the other* were questioned or rebuffed by students) also help substantiate the "when and how" of Question 3 and support deeper intentionality in the use of direct assistance. Finally, this analysis led us to revisit the scholarship on joint activity both as a reservoir of theoretical lenses for interpreting the dynamics of pedagogy in TAP, and as a way to note when the relational densities of direct teaching may be underspecified within the literature.

Findings

Broadly speaking, we understand pedagogical mediation as an intellectual and social experience that can expand or diminish relations with tools, ideas, place, others, and oneself. Rather than working from the assumption that less assistance is more, or that teachers' help and students'

agency are necessarily in conflict, this stance leads us to consider how receiving guidance and engaging in shared thinking can become a developmentally generative experience of having one's mind taken seriously. This is a core postulate of recent work on educational dignity (Espinoza et al., 2020), akin to what Zavala (2018) describes as processes of “rehumanization that takes place in and through cognitive work” (p. 109).

What did this look like in the context of TAP? We found that direct assistance was often used to enact various forms of transparency and prolepsis (desired future experiences were present within current activity [Cole, 1998]), bringing children more fully into the conceptual universe of the task. In line with our call for a more nuanced—less binaristic—view of direct teaching, we distinguish between this approach and next-step forms of assistance, which may move students through a task without deeper conceptual engagement (Gutiérrez & Stone, 2002), what is sometimes referred to as the difference between “making” and “assembly” (Espinoza, 2011). When we asked children about the similarities or differences between the help they receive in school and the help they receive from educators in TAP, many described the ways help in TAP feels more substantive. Stephanie (7 years old) stated that she doesn't need help with school work, but does need help to do projects in TAP—suggesting that she may experience different forms of intellectual challenge in the afterschool space. Tania (also 7) stated, “in Tinkering, they tell you a lot about *how* to do it and then the [school] teachers are telling you *what* you have to do, like write the letter and stuff like that” [Emphasis added]. Other children similarly used the language of “how” to describe the quality and focus of help in TAP.

We also found that ascertaining the meanings of practices such as *explanation*, *emphasizing process*, *listening*, and *embodied assistance* requires a view of the ethical and pedagogical values they are enacting, what they may be responding to, as well as the possibilities they are working to open up downstream. A sense of patience in understanding how pedagogical practices function over time is therefore important to developing more nuanced understandings of what may be interpreted as adult-centered. Finally, we found that attuning to the potential generativity of direct assistance required a view of how it was situated within and helping to build a larger ethos of joint activity—a lens we weave throughout our analysis. We substantiate these arguments through an analysis of each practice, and the storying of examples whose details compel the search for new interpretive grounds.

Explanation

We understand explanation as a practice of making the “hows” and “whys” of scientific/artistic processes and phenomena transparent and open for shared thinking. Our decision to closely analyze educators' explanations was motivated by our sense that the practice is typically eschewed within child-centered approaches to scientific inquiry in favor of students developing their own explanations, and is sometimes positioned with the making literature as a relic of hierarchical rather than everyday, practice-based expertise (Holbert, 2016). We examine these assumptions through an account of the ways explanations lived within TAP, and stress that the *how* of explanation matters. Rather than arguing for its categorical usefulness, we consider how the intentional and artful crafting of explanations can create portals into the wider conceptual universe of activity and convey a sense of intellectual respect.

Our analysis of 253 instances of explanation led us to see that adult explanations were most often used to introduce the workings of a tool, mechanism, or machine; to narrate or make transparent the “why” of particular practices (a teacher explaining why she was holding a hammer further back on the handle); or to work with children to interpret the results of a test run. Many of the instances of explaining how or why something works appeared in circle time as a way to introduce children to the day's activity, and almost all instances of working to explain a result or test-run appeared during workshop time. To illustrate these forms of explanation and how they



Figure 1. Light painting.

worked together, we offer a series of examples from a light painting activity, which involved using small LED lights to trace figures in the air which were cumulatively captured by a camera with a long exposure. The camera then produced “paintings” of these movements (Figure 1).

Here is how Walter introduced light painting during circle time:

We’re making images with light and we have a bunch of LEDs and light sources... So we have a camera and what the camera does is it’s not taking a video, it’s just taking one picture but we have it dark over there because basically we’re opening the shutter of a camera so the camera is preparing to collect light and it stays open so anything that you do with light ends up being trapped in the image that stays in the camera. It’s kind of like if you think of the camera as a painting and if you use the light painting tools, every time you turn on the light it actually adds to the painting. It’s sort of like you’re building up light on the painting (*moving his hands in a circle*).

The group became noticeably focused on Walter’s explanation. Having built an initial sense of the activity, Walter then drew students’ attention to the monitor where he shared a few of the model light paintings created by TAP staff. Students smiled and commented as they saw the images, which included one educator breathing fire, and another making a silly face. Walter physically demonstrated the gestural movements they had used to make the images. He then stood up and enacted a series of simple gestures (a circle, a star) with exaggerated movements, inviting students to guess what shape he was making in the air. While guessing, a few students practiced making their own images in the air. Walter continued: “when you’re moving through space you have to think about where you’ve been and where you’ll be because the camera’s gonna think about it all for you. So, it’s really fun to try to figure out how to do that” (FN5, 2/10/14).

What kinds of pedagogical work did Walter’s explanations do? First, he offered multiple ways of thinking about the phenomena and the work of the camera: as a collector of light that captures images (scientific phenomena), as a painting that acquires brushstrokes through exposure to light (metaphorical thinking), as a thinker who notices when actors are moving through space (animating artifacts and inviting a relational view of the camera). While all three were designed to support children’s engagement in the activity, they did so by inviting a deeper conceptual relationship with the phenomena. Scholars of apprenticeship learning (e.g., Collins et al., 1989) will likely recognize such moves as the ways experts make their thinking visible to novices. Yet we also see this approach as offering children a more dimensional—agentive, intellectual, artistic—relationship with their impending activity; explanation as a way to sow phenomenological conditions for particular qualities of experience. This is notably distinct from interpreting explanations that appear early in activity as deflating inquiry.

This moment was followed by sharing multiple examples made by the pedagogical team and then modeling gestures in ways that helped students see the connection between Walter’s initial explanation, the example light painting images, and the gestures required to make them. These moves illustrate how direct assistance did not stand alone, but was embedded in an ethos of joint

activity: educators were positioned as fellow artists and makers, and children were invited into practicing the kinds of gestures that would produce images like those shared in the examples side by side with adults. Anticipating some of the challenges that might arise through children's first attempts, Walter also narrated their practice gestures in ways that supported them to think like light painters ("you have to think about where you've been and where you'll be") and framed the process as "really fun to try to figure out." Taken together, the proleptic movements layered into such explanations illustrate how attuning to the dynamics of joint activity can support more nuanced analysis of direct assistance. They also offer an artful example of framing and introducing activities, a key site of intentional design that deserves greater attention within models of teacher learning in the domain of making. As teaching-artists, Walter and Meg both recognized *the creation of experiences for others* as central to their craft, a sensibility that powerfully supported their teaching.

Later this day, Anthony (a young adult educator) created a live light painting for students, and Walter narrated as follows:

So, you see all that stuff he was doing sort of patiently, figuring it out (*using his hand to draw in the air the way Anthony had done*) and **the reason he's so bright** and lit up is because I hit him with this flash (*triggering the flash to demonstrate*). And what that did is it lit up everything in the frame and the camera was able to capture it. And without it you would have seen just a blurry white area.' Meg added that the flash can 'make your face part of the light painting.' (FN5, 2/10/14)

While attuning students to Anthony's patient movements, Walter and Meg paused to explain the reason the painting had turned out so bright. Explaining how and why certain results emerge can expand students' relationships with what is possible within the activity. Inviting students to carefully observe others in the act of making can also encourage keen attention as a form of learning centrally valued within pedagogies of joint activity (Rogoff, 2003). Thinking from the perspective of children, we ponder the difference between witnessing such happenings within a making setting and elders pausing to explain the reasons behind why things happen as they do. Rogoff et al. (2016) discuss the ways learners within informal settings are "motivated to be involved and need to understand the phenomena in order to contribute well" (p. 389). The assumption that it is important for children to know the inner workings of tools suggests that they are positioned as full participants in the activity and that the distribution of knowledge is essential to the ideas and projects adults actively envision them creating. These, we suggest, are some of the subtle ways explanations can convey the taking seriously of mind.

Looking at the iterations of students' light paintings on this day reveals how their initial drafts often reflected the models shared in circle time, while their later drafts diverged, expressing their own invented strategies and styles (including some who played with the flash technique). These activity flows suggest the need for patience in interpreting whether introductory explanations function in ways that constrain or productively scaffold children's thinking and creativity. In the weeks that followed, Meg asked students to explain light painting to children who were new to the activity. Here are two of the explanations offered:

I liked how when you draw it ... how when you're taking a picture it shines and shows the words you're trying to make so it doesn't just click and you have time.

It like looks invisible but then it's on the camera, its um, not invisible.

We see in these explanations echoes of children's experience within the activity *and* of Walter and Meg's initial introductions, including students' efforts to think about what peers might need in order to grasp the activity. Across our analysis, we found that children's explanations of phenomena often emerged both from first-hand experience and from the explicit explanations made available within the setting.

A contrasting case (detailed in Vossoughi et al., in press) shows how direct assistance can falter when disconnected from joint activity. Here a novice educator was working with a student

named Aiden on their project and picked up the wire stripper to strip a piece of wire for the next step. Aiden looked away as part of his project was completed for rather than with him. A few seconds later Aiden grabbed the wire stripper and a piece of wire not connected to his project and tried to strip it, suggesting that he may have felt outside the activity at this moment, and wanted to learn how to use the tool. The distinction between doing with and doing for, and the degree to which explanations move from a sense of what children may need to meaningfully enter into a task, offer some ways to think about when and how direct assistance can be generative. A key issue is whether a sense of “we” or togetherness is present or emergent (Espinoza, 2011; Vossoughi et al., 2020), as exemplified through Walter and students’ side-by-side gestural movements alongside his narrations.

We also found that adult explanations were often productively interwoven with children’s observations. During a circuits activity where LED lights, wires, and batteries were used to create wearable art, Tania (now 9 years old) showed Meg that the light on her headband was turning on when the pliers she was using touched the end of the wire she was twisting. Meg (visibly excited) said, “You know what’s happening?! The electricity is traveling through the pliers,” to which Tania responded, “Yeah! Cause it’s metal” (FN8, 3/10/14). Here Tania and Meg jointly constructed an explanation for the phenomenon she was noticing. Within an environment where such joint discourse was common (this was Tania’s 3rd year in the program), Meg’s initiation of an explanation did not position her as its sole author, and allowed her to support Tania’s thinking in the moment.

Explanations also sometimes seeded student questions. During the same circuits activity, Walter described the design of the LED “legs” to Shauna (9 years old) as follows: “These are sort of set apart on purpose because if they touch then you can get a short circuit.” Shauna replied “what’s that mean?” Walter explained: “That means any electricity that jumps across this gap. Like if this is bent and touches this one then your light won’t turn on.” Walter could have simply told Shauna not to let the legs touch. Instead, he noticed an opportunity to explain the workings of the circuit by attuning Shauna to their purposeful design, and with an invitation to gain a deeper understanding of circuitry (“then you can get a short circuit.”). Advising making educators to avoid rather than carefully introduce complex terms (a practice we have witnessed on numerous occasions) occludes what Rogoff et al. (2016) characterize as the difference between explanation in the service of ongoing activity and that which is didactic and removed from activity. It also overlooks the ways creating an ethos of inquiry and observation need not rely only on the posing of questions, but can be supported through the saturation of pedagogical talk and explanation with various forms of openness and transparency, and in the case of the short circuit, with the thoughtful use of technical terms that invite students’ curiosities and convey a sense of intellectual respect. Indeed, when we looked at the ways *explanation* overlapped with various STEAM practices, we found the highest degree of cross-coding with *inquiry and iteration* (123 instances).

In describing the LOPI model, Paradise et al. (2014) argue that “guiding and directing comments augment rather than replace firsthand learning” (p. 120). This section outlined the mutual relationship between first-hand experience and explanation, such that observation and participation may also augment guiding and directing comments. More broadly, residual binaries such as *knowledge construction based on experience* versus *internalization based on didactic explanation* not only conflate qualitatively distinct forms of explanation, but ultimately replay deficit views of children by overlooking how they routinely make dynamic use of multiple sources of knowledge. Thus, specifying the relationships between explanation and joint activity may go further in helping us understand the qualities of generative explanations.

Emphasizing process

Given that making environments are often organized differently from conventional schooling (Martin, 2015), pedagogy plays an important role in mediating how children orient toward the

process of learning and experience a sense of capability in the domain. This dimension of our argument resonates with Freire and Macedo (1995) view that educators should be intentional about reconfiguring learning in ways that contest hegemonic values, which passive or hands-off approaches are likely to reproduce. One way TAP educators worked to deepen students' relationships with learning was by infusing the setting with forms of activity design and pedagogy that elevated the process of making (e.g., developing ideas, collaborating with others, drafting, and iterating). The pedagogical language developed within TAP also routinely positioned children as in-process alongside and in conversation with the emergent nature of the projects they were making. Inviting artistic dispositions toward tools and materials, educators worked to reframe mistakes as unintended outcomes that provide valuable feedback and create openings for revision and collaboration, what Dyasi (2014) referred to as "learning the language of" materials. In this section, we consider how the intentional practice of emphasizing process emerged within and helped to deepen joint activity.

We found that educators often emphasized process as a way to *think of multiple ideas and solutions*, and to *learn how to use new tools and techniques*. These two purposes account for almost half (133/306) of the instances of emphasizing process within TAP. These practices were aimed at inviting children to orient toward the process of making as replete with opportunities for thinking, and helped cultivate an ethos of second chances (Rose, 2012). Of significance, *emphasizing process in the moment of unpleasant feelings* appeared only 15 times within the data set. We surmise that the extensive pedagogical energy put toward emphasizing process prior to engaging in activities (think of Walter's "It's really fun to figure out how to do that") may have played a role in the relatively few instances of using this practice to reframe frustration in the moment, an interpretation that aligns with our earlier discussion of the grounds such framings can create for students' experiences within activity.

When educators emphasized process to support the development of multiple ideas and solutions, they often used different kinds of models: sharing multiple completed models (FN20, 9/17/14), student models (FN5, 2/10/14), and incomplete or faulty models (FN15, 5/5/14). Here, direct assistance was embedded in joint activity through the stories that accompanied models and the ways they invited different relationships with learning. These stories usually illustrated why the creator (initially program staff, and over time children themselves) created the artifact, how they made use of the feedback from materials and tools, and advice on how to navigate specific challenges. Through such stories, educators shared their belief that iterations were not a sign of a failure, but marked the emergence of new ideas to think with and learn from, a process Meg frequently connected to the work of artists, scientists, and writers:

So, a lot of artists and scientists use drafts to like come up with ideas... You start that idea and then it turns out there's something that doesn't work about it and some things that work better and you can do another version and that's another draft. Writers also use it. Writers do drafts of their written work... artists do drafts of their art. (FN9, 03/17/14)

The language of drafts was intentional, an effort to substantively ground process in *craft* rather than in individualized notions of persistence or "embracing failure" (Vossoughi et al., 2016, p. 216). Considering the shared value around process within the literature on making, greater attention to the specific ways educators encourage and model this disposition can help generate resources for teacher learning and creativity.

When student projects were used as models, care was taken to create a sense of safety for children who may have been hesitant to share their work. Before students' light paintings were shared on the monitor, for instance, Meg positioned the children painting as teachers and the children observing as learners by suggesting that they can learn by watching, even if what appeared on the screen was not what the painter intended to make (FN5, 2/10/14). During the activity itself, Meg said, "concentrate on watching and see if you can guess what they are doing." In addition to helping students better ascertain the relationship between physical gestures with

light and the image on the screen, Meg's positioning of student attempts as valued opportunities for collective learning invited a more expansive view of process, including the idea that what is shared need not be perfected work.

When incomplete or faulty models were shared, children were invited to collectively generate ideas for revising the project. For example, Meg introduced cardboard automata (mechanical devices that utilize axles, cams, levers, and gears to tell a story) by providing models that were unfinished and asking students to imagine what they would add to be the moving piece (FN15, 5/5/14). When she invited students to notice the circular movement of one faulty model, Laila suggested that it could be "a Dancer!" Theodore added, "a garbage can!" A few people laughed and Meg said, "Cool. A rotating garbage can." Then Denny (adult educator) said, "A blender!" to more laughter. Meg then showed everyone a more complex, unfinished model that involved a snail cam, consisting of an up-down motion with a slow rise and sudden drop. Arthur proposed the idea of "someone flipping over while riding a unicycle and then bumped his eyeball!" Meg said, "I like that idea cause it means you'd have to really think about how to make all that happen up here ... that would be very complicated."

Here, Meg emphasized process as tied to joint activity in a few ways. The discussion was designed to elicit collective ideas and solutions, rather than "answers" only from children. Meg also introduced specific automata models that highlighted different actions (rotation, up-down motion), and invited ideas that complimented the motion. Meg welcomed wild ideas (Kelley & Littman, 2001), such as the garbage can and the man bumping his eyeball. Arthur's "man bumping his head" was also picked up in a way that acknowledged the complexities, but affirmed possibility. Rather than dissuading or simplifying the idea, Meg stated that she liked it *because* it would be complicated—a sign, in our view, of intellectual respect. We noted across our data that the idea of something being "complex" generally had a positive valence within educators' talk.

TAP educators also emphasized process when supporting children to use new tools and techniques. Locating challenges in the tools or materials (e.g., "those LED legs can be tricky!" or referring to a tool as "finicky"), for example, served as a one way to de-individualize struggles, and to position students as members of a community who share insider knowledge about tricky tools. Invitations to try new activities were also typically followed by some form of low-stakes practice, whether the words used were "drafts" (FN22, 10/1/14), "try it" (FN18, 7/10/14), or "experiments" (FN4, 2/3/14). When Walter was modeling how to begin a spirographs activity and the gears slipped (leaving an unintended mark on the paper), he said "It slipped ... But it's ok cause this is just a sketch. I'm trying it out to see if I can get the technique down cause it does take a little bit of technique and practice." Such intentionality of language suggests that educators were thinking from the perspective of children new to activity, in this case defining the felt experience of novelty as a starting point for practice, rather than a sign of incapability. James, a former student and long-time young adult educator in TAP, summarized the dispositional fruits of such experiences as follows: "You've helped me a lot with understanding the separation between not knowing things and just learning things. Like not going into something as: 'oh I don't know this'" (Debrief session, 08/13/14). At its best, the pedagogical emphasis on the process can transmute a sense of oneself as not knowing into a kind of reverence for the beginner's mind (Suzuki, 2010).

At times, the language of process and drafts landed differently for students. When Meg discussed the importance of experimenting and changing ideas during a circle time introduction, Felix (8 years old) showed signs of concern and said "You mean, like, give up?" (Memo, 11/21/13). Felix may have associated persisting with an idea as a sign of commitment and capability. He may have also understood shifting ideas as giving up based on schooling practices that assume one best path to the "right answer." This contrasting example reminds us that students are navigating a range of explicit and implicit narratives about process across learning environments. Felix expressed his concern to Meg, who responded by saying, "Not give up. Just re-adjust your ideas. Based on what really happens in front of you" (Memo, 11/21/13). This exchange provides

further evidence of what opens up through an ethos of joint activity. Felix acted as a full conversation partner, enacting the right to pause and question in ways that may have helped clarify what Meg meant for others as well. Meg responded as a fellow artist might, making a suggestion for how to be responsive to the materials one is working with. At the same time, it points to the need for programs like TAP to be prepared to help students wrestle with the complexities of distinct values and demands across settings (Vossoughi & Gutiérrez, 2014).

We see throughout this section that educators approached interactions with students as opportunities to emphasize process through the nuances of pedagogical talk, design decisions, and positionings. The frequency and heterogeneity of these moments helps us see what it can look like to envelop students in a semiotic ethos that values the indeterminate processes of making and learning as a context for deep intellectual activity. Resonant with our discussion of explanation, we also see how pedagogical talk that models what it looks like to take the mind at work seriously (Rose, 2005) can open up more generous relationships with one's own thinking and learning.

Listening and observation

Having explored two different forms of pedagogical talk, we now consider how a nuanced view of teacher listening and observation supports an understanding of direct assistance as tied to joint activity. While much of the extant literature on child-centered learning endorses adult listening and observation, these practices often become understood as recipient, unidirectional acts that are important insofar as they make room for student voice and agency. In the context of making, forms of listening are often treated as a means to the desired end of “self-directed learning” (Kurti, Kurti, & Fleming, 2014) rather than dynamic practices that can beget productive forms of guidance. Important exceptions that guide our thinking include scholarship that has underscored the need for educators to carefully attune to children's meaning making on their own terms as the grounds for supporting generative forms of dialogue and epistemic heterogeneity (Bang & Marin, 2015; Gutiérrez, 2008; Lee, Spencer, & Harpalani, 2003; Rosebery, Ogonowski, DiSchino, & Warren, 2010). Understanding the role of listening and observation beyond an adult- versus child-centered binary therefore requires close attention to what educators *do* (in the moment, and further downstream) with the pedagogical insights gained from careful attunement to children's thinking (Schultz, 2003). Direct assistance informed by deep listening can signal intellectual respect and a valuing of children's questions within joint histories of talk and participation. Thus one of the ways we analyzed the situated generativity of direct assistance was to notice how it flowed from observing and listening to children's meaning making.

In TAP, forms of direct guidance and joint activity routinely emerged in relation to practices of listening and observation ($n = 243$). In most cases, this guidance did not appear to stifle children's voices, but instead, played an integral role in affirming and substantively engaging with children's ideas. These relationships are further specified in Figure 2, where we identified the following key practices as indicators of educators' listening and observation: (1) direct observation, (2) inquiries into students' ideas and goals and (3) re-voicing. Re-voicing refers to reflecting back some or all of a previous comment, often in conjunction with a unique idea or a conceptual reframing (Cazden, 2001). When Meg asked long-time participants to explain automata to a group of newcomers, for example, Arthur said, “Um, they're like gears?” Meg responded, “They're like gears. Cool. They have gears. What else?” Meg affirmed and extended Arthur's comment by clarifying that automata *have* gears as one component. We compare this example of revoicing with another, less generative instance when a more novice educator said to a student, “Come on, let's go solder,” to which she replied, “What's solder?” The educator's next directive, “Tell [Walter] to solder it **for you**” did not demonstrate listening (FN, 03/31/14) and contributed to a dynamic where the child pushed back on the tenor of adult assistance in the moment (saying, “I want to solder it”), and in subsequent instances that day. This instance reflects the distinction

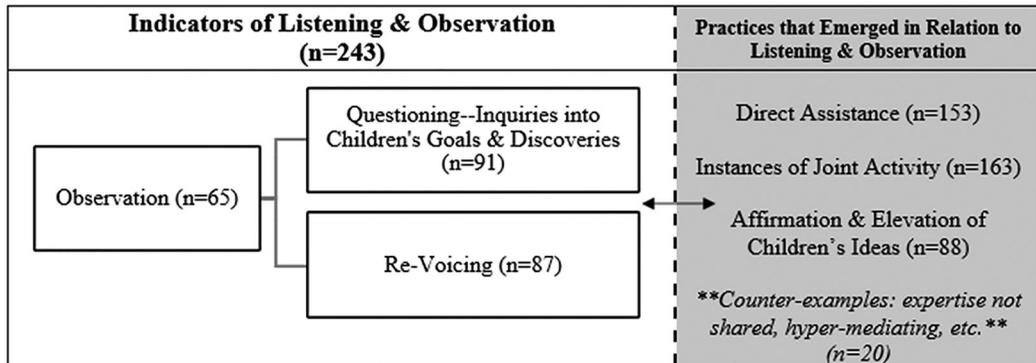


Figure 2. Practices co-occurring with listening and observation.

between *doing for* and *doing with* discussed above, and further evidences the ways an ethos of joint activity helps to shift the quality and meaning of assistance. The frequencies and counterexamples of listening and observation are represented in Figure 2.

We found that acts of listening and observation (on the left of Figure 2) were often consequential to shaping direct assistance and joint activity (on the right of Figure 2), hence their frequent co-occurrence within our dataset. Collectively, the flows between listening, observation, and subsequent forms of pedagogical talk and guidance also show how educators conveyed a kind of intellectual respect that was discernible through the textures of assistance built on insights gleaned from careful listening. We therefore argue that educators' practices of listening and observation, when taken in context and coupled with other forms of pedagogical practice, shift their resonance beyond an adult- versus child-centered binary.

We further illustrate this finding through an example from circle time. Here Tania shared a suggestion for using labels on paper circuits to keep track of the terminal ends of a battery. Paper circuits used copper conductive tape, LEDs, and a small battery to create a design or card out of paper.

Tania: "um, can we like label on the tape, if we forget, like, I said I forgot which side to do it, so like, can we label it (*showing two different sides with her finger*) on the tape?"

Tania's suggestion was directly connected to a challenge she had encountered while designing a wearable circuit the week prior. Earlier, Tania shared that she became confused during the process and had a hard time deciphering the positive from the negative end. Walter and Meg's responses moved between encouraging, revoicing and extending Tania's inquiry:

Walter responded, "Yeah, definitely. You can label the tape so that you know what side is positive. And you can even label the legs of your LED's so that you know, if you're gonna put more than one light on, that it always goes to the right place." Meg added, "That's good cause Tania said that was something she discovered last time about the lights you have to flip sometimes. So, you can always label it to help you understand it."

Introducing domain-specific language extended Tania's understanding and endorsed her suggestion as one worthy of collective engagement. Walter's response was not purely teacher script, but rather a coauthored explanation infused with both his and Tania's ideas (Gutiérrez et al., 1995). Though our earlier discussion of pedagogical talk often looked forward from key stretches of discourse to consider how they mediated student experience, here echoes of student ideas within teacher talk offer another way to see the dialogic qualities of direct assistance (Bakhtin, 1981; Tejada & Espinoza, 2003).

Treating listening itself—or re-voicing absent the extension of the idea—as a sufficient pedagogical response might have left the issue of Tania’s uncertainty unresolved, or fallen short in making visible the conceptual knowledge and ideas infused in Tania’s talk. Instead, Meg re-framed Tania’s expression of confusion as a discovery, shifting Tania’s position from unknowing to learned (Enyedy et al., 2008). Walter and Meg demonstrated that they were listening to Tania in ways that assumed her thoughtfulness and emerging expertise, in tandem with understanding themselves as responsible to support her and her peers’ learning. Alongside the resources for teacher learning described in prior sections, here we see how nuanced models of pedagogical listening can support educators to notice the layered qualities of this practice, and productively trouble the notion of listening as passive.

Later that day, Tania employed her idea of labeling the tape while constructing a paper circuit with three bulbs on a curved path (FN, 03/17/14). Tania demonstrated an openness to testing and troubleshooting a complex design, a shift from the reticence she had expressed earlier that day. Looking across Tania’s long-term trajectory within TAP (she participated in the program for 3 years, and later served as a youth educator), we found that Tania carefully employed the forms of listening described here with her peers, and with younger children (Vossoughi et al., 2020). This included ample instances of Tania working to understand children’s ideas and goals before providing assistance.

Many of the instances in our data that included young adult educators also showed that they were actively learning to move between listening, observation, and talk in the service of student growth. Taken together, these interactions suggest that pedagogical responses that follow after close listening can serve a key role in positioning the questions, struggles, and solutions proffered by children as *ideas*, fundamental to the collective work at hand. Thus, moving beyond binaristic pedagogical logics requires a functional and temporal view of practices like listening and observation, and the kinds of intellectual and relational experiences they can engender.

Embodied assistance

In this final analytic section, we consider how embodied (physical, gestural, material) forms of assistance can organize learning in ways that transcend adult-child centered binaries. We found that looking closely at the embodied dimensions of pedagogy in TAP supports a reimagining of the you/I binary and provides another window on the emergence and sustenance of joint activity. If residual binaries such as dialogue versus telling flow from the dichotomy of adult- versus child-centered learning, we might consider the you/I binary as even more primary, an assumption about the learner as an individual and autonomous subject that undergirds binaristic pedagogical thinking, akin to what Mejía-Arauz et al. (2018) define as the difference between separate individuals engaging in negotiation and individuals as inherently socially engaged and collaborating to coordinate.

In prior work, we identified key *embodied movements* that TAP educators enacted to support joint activity across adults and children (Vossoughi et al., 2020). Micro-ethnographic analysis of these embodied movements and their life-spans helped us see how they opened up qualitatively distinct relations over time. We found, for example, that students new to TAP often pulled their hands away when an educator’s hands entered the project space. However, through educators’ continued use of embodied movements and explicit choreography (e.g., “keep your hands on”), we noticed that long-time participants kept their hands on their artifacts or tools even when adults’ hands entered the activity space, signifying a shift in the meaning of adult intervention from doing *for* to doing *with*. We also came to see the routine practices of seasoned educators such as *I start the task you complete it*, or *a problem emerges, we co-investigate* as models through which to support novice educators’ learning. We further explore the role of embodied assistance in pedagogies of joint activity through a closer look at the practice *I do one part you do the other*.

Coded 82 times, *I do one part you do the other* describes moments when one person physically or verbally carried out part of a task while other participant(s) did another. Often initiated through explicit adult direction, we found that this practice opened up interactions in which students pursued new and unanticipated STEAM inquiries (30 of 82 instances), and built new relations with adults and one another (32 of 82 instances). Analyzing the intellectual and affective qualities of this practice also led us to see how *I do one part while you do the other* created opportunities for educators and students to transcend the you/I binary and begin moving as a collective subject, where thinking and experience are shared across multiple bodies (Cole & Engeström, 1993; Gallagher, 2010; Ma, 2017; Marin, 2020), and where a “we” emerges that is ontologically distinct from individual subjects pursuing their own goals within activity (Espinoza, 2011).

The following example illustrates the potential of this pedagogical practice. May (an adult educator) was helping Tania and Rita (both 6 years old) attach a running motor onto their scribbling machine, which used motors, everyday materials and markers as “feet” to draw and investigate compelling designs on butcher paper. Using *I do one part while you do the other*, May took advantage of her own spontaneous noticing to draw students further into the conceptual universe of the task (Figure 3):



Figure 3. Scribbling machines.

May held the motor onto the scribble machine as Tania worked quickly to tape it in place. As she was holding the motor, May said “oh oh oh oh oh!” and told Tania, “feel my hands.” Tania placed her hand on May’s, smiled, then went to pull her hand away. May stopped her by saying “wait,” turned to Rita, then said, “feel Tania’s hands.” Rita placed one of her hands on Tania’s, pausing to embrace the sensory exploration of the motor, all three smiling as they felt the vibrations transfer through their hands.

Once May recognized the energy transference at play, she excitedly shared the phenomena with Tania and Rita. May’s improvised coordination of their hands allowed each person to feel the vibrations, creating an embodied sense of the physical and conceptual qualities of the motors that required coordination across the three participants. In line with our assertion of the need for temporal analyses of direct assistance, we found that roughly half the coded instances of *I do one part you do the other* resulted from such explicit pedagogical action (43 instances).

Earlier we described how pedagogical narratives that emphasize process were often supported by taking the perspective of children new to activity. In this case, May’s actions also validated her own intellectual pursuits as equally generative for the learning at hand, a marker of authentic joint activity. Rather than working only in the service of children’s questions, May drew from her own curiosities about the phenomenon to co-construct an experience they could all share. Here we see a movement beyond the teacher/student and you/I binaries both in the ways May organized for joint learning and in her orientation toward Tania and Rita as both learners and co-thinkers with whom she could fruitfully share her observation. The impact of this pedagogical move was further evidenced a few moments later, when Tania directed a peer to place his hands alongside hers as they worked through a problem. Treating students as both learners and

co-thinkers, as May did here, conveys a respect for young people as legitimate participants (Lave & Wenger, 1991), offering guidance while always being prepared to learn from their interpretations and ideas.

Our final example considers the tensions and complexities that can emerge in organizing for *I do one part while you do the other*. Here Meg worked to enact this movement while building a cardboard automata with Shauna (then 6 years old), who asserted her agency by taking up the formation of a “we” on her own terms. Meg was supporting Shauna to build a foundation for the automata by taping triangle cutouts to the corners of a foldable cardboard square, keeping the square from folding inwards (Figure 4):



Figure 4. Cardboard automata.

Meg held the cardboard square in place as Shauna placed two pieces of tape at the corner. After Shauna placed the second piece of tape, she told Meg “I want you to tape it.” Meg said, “you do? I’ll tape this one and **then you can**...” Shauna said, “I don’t want to.” Meg said, “I’m just gonna do this end to make it more sturdy. And **then we can** do the other end too.” ... After placing another piece of tape, Meg asked, “you wanna do the next one?” Shauna said “nope” but took the tape from her and started taping the corner. Shauna pushed the cardboard square towards Meg and said, “I can’t. I can’t do it.” Meg said smiling, “You just did.” Shauna said, “No I didn’t. I’m [a] failure.”

Shauna initially declined Meg’s bid for *I do one part while you do the other* by asking Meg to tape first. Meg then invited the practice in the form of modeling. When Shauna refused, Meg reframed her invitation by saying “we can do the other end too,” dispersing the risk to the collective “we” instead of just “you” (Shauna). Later in the interaction, Shauna seemed to feel discouraged, saying “I’m [a] failure.” Shauna’s hesitation raises questions about the limits of joint activity as a pedagogical strategy in some instances and the challenges educators encounter when children may be feeling a sense of frustration or questioning their own capability. Such moments are likely familiar to educators working in making settings.

Although Shauna pushed against Meg’s bid for collaboration, we see also that Shauna was already engaged in *I do one part you do the other* by holding the cardboard square in place as Meg taped the corners. While she hadn’t directly instructed Shauna to hold the cardboard square in place, Meg did embody a potential way Shauna could participate in the task while someone was taping by holding the cardboard square, and when they switched roles, Shauna took up this role. By subtly modeling forms of participation that Shauna could take up in the activity, Meg organized for *I do one part you do the other* while respecting Shauna’s decision not to tape. A few moments later, we noticed a shift in Shauna’s participation:

Shauna worked to figure out where the hole would go on the cardboard square as Meg brought her a wooden skewer. Shauna took it and poked it through the hole, saying, “**so we** could put it in here like this—” Meg continued, “—so that way you’re gonna see where the other hole needs to be.”

Although Shauna was initially hesitant to tape the corners, she now readily placed the skewer in her automata, taking up portions of the activity at her own pace. Shauna also used the pronoun “we” in sharing her ideas, indicating that she viewed Meg and herself as coauthoring the design, further evidenced through Meg’s verbal completion of Shauna’s statement.

What might this counterexample teach us? Although Shauna initially rejected Meg’s bid to engage in *I do one part you do the other*, she still viewed herself as working in collaboration with Meg, signaling how an ethos of joint activity continued to inform the direction of the interaction. Despite Shauna’s initial refusal, Meg remained patiently connected to the activity, allowing Shauna the space to negotiate next steps on her own terms. In addition to demonstrating the importance of temporal analyses that attune to ongoing activity flows, this example helps us see how joint activity can support forms of repair, sustained relations, and negotiation of roles even when individual instances of assistance may not unfold as intended.

Discussion

Through a close examination of teaching within TAP, we have sought to contribute pedagogical resources to the growing field of making education and research and to argue that interpretations of pedagogical practice that are overly constrained by adult-child centered binaries are not serving us as a field. Primary among these are monologic misperceptions of direct forms of assistance that, when embedded in (and productive of) an ethos of joint activity, can function in ways that are developmentally generative. A fundamental layer of this generativity involves how particular qualities of pedagogical talk, listening, and embodied assistance take children’s intellectual activity seriously in ways that can shape their relationships with the conceptual universe of the task, with proximal others, with their sense of emerging competence in the domain, and with the process of learning itself. Reflecting on our own efforts to move beyond received binaries, we conclude by naming analytic principles that support the development of more adequately complex perceptions of pedagogical activity and their implications for teaching, design, and research.

First, we have illustrated the need for vigilance with regards to the residual binaries that flow from adult- versus child-centered frames. Noticing either-or thinking (direct instruction *versus* dialogue, explanation *versus* material exploration) is important to considering how these modalities can work together in the lived textures of teaching and learning. Rather than choosing if to explain or let students figure out particular concepts or techniques, design decisions can therefore shift to consider the *when* and *how* of practices like explanation. This includes supporting educators to orient toward pedagogical guidance as a craft, replete with opportunities for sharing knowledge and modeling inquiry and multiplicity in ways that leverage the cultural and aesthetic power of talk-in-interaction (Espinoza, 2008; Warren et al., 2020). It also means investing the time it takes for educators to approach pedagogical design as artistic activity, and to engage in making itself as a resource for sensing the conceptual layers students may encounter. As reflected in Walter and Meg’s practice, supporting educators to embrace the axiological responsibility for *creating experiences* with and for others (sowing conditions for co-presence) can help move beyond the unproductive anxieties that undermine pedagogical leadership within child-centered frames (Bang et al., 2016; Zavala, 2018).

This is closely connected to a second analytic principle: cultivating temporal sensitivities that trace the histories and futures of pedagogical practice. The generativity of Walter’s explanation of light painting was perceivable in so far as we attuned to the ways explanation and gestural collaboration worked together and expanded relationships with the activity over time. Similar grounds for experience and conversations with materials and tools (Dyasi, 2014) were cultivated through the use of pedagogical narratives that emphasize process. As James reflected (“You’ve helped me a lot with understanding the separation between not knowing things and just learning things”),

sustained experiences within an environment that routinely emphasizes process can shift participants' relationships with learning itself.

Monologic misperceptions (Espinoza, 2008) of teacher discourse tend to focus on airtime (less for teachers, more for students) rather than paying attention to the rich and potentially unanticipated ways the seeds planted through pedagogical narratives grow over time, or the ways teacher talk is coauthored by an evolving history of students' questions and ideas. Though we have argued the need for temporal attunement on the part of researchers, we also consider a sense of *patience* with regard to the ways students make use of what is being offered pedagogically as a powerful disposition for educators. The rush to see particular manifestations of student voice early in a program or setting can align with neo-liberal logics of efficiency (Baldrige, 2019; Brown, 2015), and occlude the ways patient activity—listening with humility (Schultz, 2003), moving together at a careful pace, trusting the process of shared meaning making—can nourish intergenerational relations and signify a proleptic belief in the genius of young people.

Our counter-examples also taught us that absent relations characterized by mutuality and joint activity (e.g., doing for rather than with, listening less closely to students' ideas), direct assistance can be less productive and reproduce the limitations of adult-centered learning. Similarly, appeals to student voice and agency may fall flat without the relational conditions that support such shifts in participation. Temporal sensitivities therefore caution against the over-interpretation of discrete pedagogical actions without a sense of their histories and purposes, and of their embeddedness in a broader relational ethos. At the same time, micro-genetic moves play a role in building such an ethos and can be a part of establishing the conditions for shared thinking and collaboration in any given moment. Analytically, then, looking forwards, backwards, and sideways from particular pedagogical moves can support such historicity and contextualization at multiple scales of time.

A third analytic principle involves moving away from the reification of the learner as an individual, autonomous subject, and working to design for and trace the emergence of collective learning (Engeström, 2000; Gutiérrez, 2008; Marin, 2020; Rogoff, 1998). The impulse to background or diminish the role of adults based on a presumed ontology of adult supremacy risks locking educators into the role of knowledge dispensers and reifying the power of Western paradigms. It also reflects a common belief that collaborations among children/youth (with adult bystanders) are more desirable than collaborations among children, youth, and adults. As we have argued throughout, direct assistance can take on different valences and meanings when embedded in shared, intergenerational activity. May's excitement about the movement of energy through multiple hands, or Tania and Meg's shared discovery of the pliers as completing the circuit on her wearable headband illustrate how positioning adults as co-learners and inquirers can tilt learning environments toward the edges of everyone's thinking, as can recognizing adults as artists and makers engaged in side-by-side activity with children. Methodologically, this orientation requires an attunement to the emergence of "we" in interaction (Espinoza, 2011), as well as forms of perspective-taking that consider what becomes visible and audible if we treat "the learner" in a given moment as constituted by multiple bodies and minds (Hutchins, 2000; Ma, 2017; Mejía-Arauz et al., 2018). Pedagogical implications include organizing for joint activity and relationality not only as the grounds for learning but also as a learning goal unto itself (Bang & Vossoughi, 2016; Nasir & Hand, 2006); and moving beyond settled knowledge as an endpoint to intentionally design for adults and young people to engage together with the unknown.

A final principle that cuts across the previous three involves our efforts to develop a wider interpretive language for describing pedagogical action. Here we refer to the descriptive syntax utilized to interpret and portray the dynamics of power and possibility within pedagogical interactions, and the ways it can replay or expand beyond binaristic conceptions of teaching. Our early efforts to rupture the binaries discussed above involved our frequent use of "and," "alongside," or "while also" to signify the co-presence of seemingly dichotomous pedagogical practices. Where we found ourselves signaling such co-presence, we worked to develop a more

precise descriptive language that could help us see how practices worked together in consequential ways rather than simply co-existing. In the original section on teacher listening and observation, for example, we described how Meg and Walter were listening to Tania in ways that assumed her thoughtfulness *while* understanding themselves as responsible to support her learning. Scrutinizing our own sentences with our central arguments in mind, we noticed that “while” functioned to position listening to children as apart from rather than integral to the active role of an educator. Our re-writings of these sentences pushed us to notice the dynamic reciprocities between listening and guiding.

To offer an even more explicit example: we noticed early on that our efforts to describe the role direct assistance played in opening up rich interactions sometimes took on an apologetic tone. Consider the following sentence, “Thus, we can see how this practice, *even when* initiated through adult direction, deepened students’ social and educational experience.” Despite our efforts to center the role of generative forms of direct assistance, default tendencies reemerged and led us, initially, to reproduce the idea that explicit forms of pedagogical action should be avoided or minimized whenever possible. In our experience, such disclaimers (e.g., “I may need to briefly lecture before getting to discussion”) are ubiquitous within progressive educational contexts. Given the feminized nature of teaching, they also raise questions about who we can be led by or learn from (Marin, personal communication, 11/17/20). Recognizing such disclaimers is therefore important to noticing the work our language is doing, and to developing an unapologetic ethic around the occasions when direct pedagogical guidance supports generative learning and educational possibility.

Lastly, our original writing of the interaction between May, Tania, and Rita described how May was sharing her discovery of energy transfer with students as a “peer.” Here again, we recognized how we were participating in either-or thinking by interpreting moments of symmetry as void of ongoing pedagogical guidance, or productive asymmetry (Rogoff, 2003). We moved instead to describing the ways May *simultaneously* positioned students as co-thinkers and learners. This reframing opened up our own theorizing, allowing us to see that the power of May’s pedagogical moves in that moment grew from such simultaneity.

We offer these re-writings not as exhaustive or complete, but as invitations for noticing the ways pedagogical binaries constrain our analytic language, and thus, our thinking about teaching and learning. Our aim in this paper has been to draw attention to these tensions and their implications and to share our own efforts to adequately describe the complexity and generativity of direct assistance within environments organized around joint activity. Observing how making and tinkering are taken up as expansive approaches to engaging learners in invention and creation, and the important ways youth-centered spaces define themselves beyond normative schooling, we hope that the analyses offered here serve as an argument for pedagogical intentionality and artistry, for the power of intergenerational learning and relationality, and for a healthy skepticism toward binaristic ontologies of teaching and learning that hinder a more manifold pedagogical imagination.

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Appendix A.

Synthesized coding table

The following table offers a view into the major coding categories employed, as well as select codes and sub-codes. Though not exhaustive (sub-codes were much more numerous), the central codes examined within the paper are represented here and contextualized within the broader coding scheme.

Category	Representative codes	Select sub-code(s)	
LANGUAGE	Pedagogical talk	<i>Explanation</i> <i>Instructive</i> <i>Proleptic</i> <i>Restrictive</i> <i>Employing normative disciplinary language</i> <i>Emphasizing Process</i> <i>Narrative/Storytelling</i>	
	Wider forms of disciplinary talk, meaning making	<i>Treating children's talk as a resource</i> <i>Invalidating children's talk as a resource</i> <i>Invented words</i> <i>Modeling multiplicity</i> <i>Children describing their artifacts</i>	
	Drawing connections and/or contrasts	<i>Across ideas</i> <i>Across activities</i> <i>Across settings</i> <i>Across discoveries or artifacts</i>	
PEDAGOGICAL PRACTICES	Making efforts to understand kid's ideas and goals	<i>Observation</i> <i>Wait time</i> <i>Re-voicing</i> <i>Questioning</i>	
	Offering assistance	<i>Offering suggestions</i> <i>Scaffolding</i> <i>Simplifying</i> <i>Hyper-mediating</i>	
	Embodied assistance	<i>I'll do one part, you do the other</i> <i>I start the task, you complete it</i> <i>A problem emerges, we co-investigate</i> <i>My hands enter, yours pull away</i> <i>My hands enter, yours stay</i>	
	Modeling	<i>Encouraging observation/noticing</i> <i>Narrating while doing</i> <i>Presenting a diversity of models</i>	
	Emphasizing Process	<i>Encouraging testing/drafts/iteration</i> <i>Reframing difficulty/mistakes</i> <i>Emphasizing the development of ideas</i>	
	Expanding definitions of STEM	<i>Grounding science in the everyday</i> <i>Identifying an activity or practice as STEM</i>	
	Activity design	<i>Feedback from materials</i> <i>Open-ended activity to invite children's ideas</i> <i>Transparency of materials/activity</i>	
	Participation structures	<i>Circle time</i> <i>One on one</i> <i>Ensemble</i> <i>Working side by side</i>	
	JOINT ACTIVITY & RELATIONALITY	Asking others for help	<i>Asking peers</i> <i>Asking teens/adults</i>
		Fluidity of expert/novice roles	<i>Adults learning from children</i> <i>Educators positioning children as experts/knowledgeable</i> <i>Children helping one another</i>

(continued)

Continued.

Category	Representative codes	Select sub-code(s)
		<i>Lamination (adults helping kids/teens to help others)</i>
	Intent participation, learning through keen observation	
	Co-authorship of artifacts & ideas	<i>n/a</i>
	Co-struggling	<i>n/a</i>
	Experiencing the whole activity: division of labor	<i>n/a</i>
	Building relations	<i>Reaching out to others</i>
STEAM/TINKERING PRACTICES AND DISPOSITIONS	Inquiry & iteration	<i>Sharing about oneself or one's history</i> <i>Testing</i> <i>Adjusting</i> <i>Drafts</i> <i>Defining problems</i> <i>Designing solutions</i> <i>Theorizing</i> <i>n/a</i>
	Unintended outcomes as openings/opportunities	
	Unintended outcomes as hindrances	<i>n/a</i>
	Agency & familiarity with materials and tools	<i>Intrigue/interest in tools and materials</i> <i>Making decisions based on look/feel</i> <i>Familiarity with limits or possibilities of tools/materials</i>
	Electricity/Conductivity	<i>Polarity</i> <i>Parallel and series circuits</i> <i>Resistance</i> <i>n/a</i>
EPISTEMIC HETEROGENEITY	Multiple pathways	
SELF-DETERMINATION	Pedagogy of multiplicity	
	Making something one's own	<i>Claiming ownership</i> <i>Inserting playfulness, imagination</i> <i>Pursuing personal interests</i>
	Resisting/Refusal	<i>Rejecting questions or suggestions</i> <i>Resisting positioning as less than knowledgeable</i>
EDUCATIONAL DIGNITY/INDIGNITY	Safeguarding emotional or intellectual vulnerability	<i>Holding vulnerability with care</i> <i>Sharing risk</i> <i>Challenging hierarchy</i>
	Affirmation/Praise	<i>Following children's lead</i> <i>Audiencing</i> <i>Affirming identity</i>
	Deficit frames	<i>Reproducing hierarchies</i>
	Emotional quality of experience	<i>Joy</i> <i>Fear/Reluctance</i> <i>Confidence</i> <i>Frustration/Disappointment</i>
SOCIAL IDENTITY & POSITIONING	Age, Race, Gender, Class, Language, Culture, Sexuality, Immigration	<i>n/a</i>