Developing Political Activity as if the World is on Fire

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Abstract

This piece examines the formulation of political activity among science teachers during a time of rising global movements. Situated amidst continuous calls for educational reform, specifically for science teaching and learning (Bang et. al, 2012; Carter, 2005), this work forwards an argument to explicitly cultivate the political activity of teachers as a means to engage a justice-centered science (Morales-Doyle & Gutstein, 2019; Strong, 2017). The development of teacher identity (Avraamidou, 2016) in connection with the political economy of schools and society is examined through a concept of personhood (Stetsenko, 2012), positing that social change and activism is formative and integral to human nature. Using grounded theory approach, we analyzed educators' responses from dialogic interviews regarding science education in the context of a large, urban district, and situate teacher articulations and positionality regarding informal and formal science education. These articulations elucidate forms of political engagement in the context of a socio-political history of colonialism, capitalism, and imperialism (Mutegi, 2011). This piece presents a heuristic in order to widen a view of science teacher articulations and enactments - calling attention to the time and support necessary to develop a transformative activist stance (Stetsenko, 2011).

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Keywords: Science education | political activity | teacher development | personhood | activism

The youth-led Global Climate Strike in September 2019 drew millions of students, educators, families, and workers to urge action on a host of interrelated environmental and social issues (Carlisle, 2019). For New York City public schools, the Department of Education put out a statement that it would provide excused absences to any of the students who took part in the climate strike. News outlets reported between sixty thousand to two-hundred fifty thousand people in attendance, including students, parents, and community members (Barnard & Barron, 2019). Students and educators were among a host of concerned individuals engaged in political activity through demonstrations and actions across Manhattan. Along with the 2019 climate strike, there have been amplified calls to link climate justice and racial justice movements particularly in urban areas (Bravo et al., 2016; Mikati et al., 2018; Thomas, 2020). These movements emphasize a link between politics, activity, learning, and schools. In this piece, we ask the following questions: How does political activity emerge in schools and more specifically

in teaching science? What are the articulations, stances, and practices of educators, particularly science educators, in this process?

This piece examines interviews with science educators in New York City on their notions of informal science teaching in schools. While this piece was developed as part of a longer research project examining articulations and practices of informal science teaching as it relates to teacher identity, we hope to explore the articulations, stances, and practices of political activity of science educators—including actions to affect climate change and make clear the links to intersectional (racialized, gendered, class-ed, etc.) disparities, within the context of global movements.

Situating Political Activity: On-Going Struggle for Justice

We contend that the political activity of science teachers can be revealed in their articulations of teaching, of the curriculum, of their students, and of their praxis. An examination into the political activity of educators is necessary to acknowledge and develop in an effort to teach the potentialities of a just science and world (Morales-Doyle, 2017, 2018, 2019; Morales-Doyle & Gutstein, 2019).

The notion of political has been interpreted from various vantage points. At times, political is interpreted in terms of casting a vote within the electoral system. In other instances, political is positioned on an interpersonal level in terms of behavior and manipulation of people. If you have ever heard the phrase, 'don't make this political,' this statement sends a message that the act of speaking on situations of power in turn makes a topic political. In other words, this way of positioning political denies the connection to particular contexts and circumstances, as is often times assumed in terms such as real-world or authentic situations, which are interwoven with histories of inequity and power. Political in this piece refers to one's activity in relation to recognizing one's "positionality" as associated to power in a social process. A social process includes the material and historical conditions from which people act upon and shape change. As such, educators can be political through activities that involve nuanced historical and analytical understandings to inform decisions enacted in immediate circumstances. In a broad sense, political activities connect a societal analysis to social struggles for control over what is produced, used, and preserved from the Earth to sustain and improve human lives. The political activity of educators is not about if they are or are not political, but rather address "for what ends, by what means, and in whose interests should teachers engage in political work" (Ginsburg et al., 1992, p. 441). Frederick Douglass reminds us that struggle is necessary in the endeavor for social justice and is not solely related to who has or is bereft of power.

Additionally, power and learning is positioned in multiple ways. A concept of power (Au, 2011; Marx, 1969; Mojab & Carpenter, 2011) is connected to the creative activities of making and doing, as well as, the decisions regarding control over the material things humans create and need to live. In this way, power is not an autonomous entity that is either solely repressive or liberating. Power is constituted via historical relations and material conditions—enacted and organized through human collective activity (Nigam, 1996). Foucault (1995) articulates power as not a thing but in terms of relations and existing everywhere. For example, power can be organized in coordinated ways as evidenced with the global climate justice strike. The result of this action was broadening visibility and increasing participation in an engagement with climate issues. Another example that demonstrates a relation of power (albeit in a different direction) is through American Legislative Exchange Council (ALEC), a conservative center that actively

coordinates and writes policy representing the material and economic interest of corporations (*ALEC Energy Principles - American Legislative Exchange Council*, n.d.). This influential group maintains that global climate change is inevitable and they "are not willing to inflict economic harm on their citizens with no real benefit" (*ALEC Energy Principles - American Legislative Exchange Council*, n.d.). In other words, it is business as usual led by a fundamental interest of profit maximization. Power, while both individually and collectively enacted and coordinated, can be connected to an understanding of learning that is situated.

As the Politics of Learning Collective (2017) wrote,

> to embrace learning as situated means to conceptualize it as inherently political: It is always embedded in and articulated through hierarchies of power and tied to particular visions of possible futures. We must continue to ask and explore these questions in all of their inevitable nuance, but we know that at minimum our efforts ought to resist the tendency to depoliticize the situated nature of learning and withstand the inclination to ignore the always-present historical and ideological dynamics and contexts (p.5).

Activities of knowing, doing, and learning are interrelated to power intersecting notions of intelligence, reproduction of social hierarchies, issues of climate change, or imposed obstacles such as an interrelated issue of affordable housing.

Everyday issues that take place in schools, such as access to healthy food or disciplinary systems that enforce compliance are linked to historical relations of power, of production and constructed hierarchies and categorization of people (Saltman & Gabbard, 2010). Struggles regarding these issues continue to intensify as capitalism expands and deepens morphing entangled structures and practices (such as racialization, incarceration, citizenship status, etc.) (Laura, 2014; Morris, 2016). Simultaneously, people continue to organize and develop activities of resistance in response. For an educator, political activity takes place through a conscious discernment and educational practice within these struggles.

Political Activity: Teaching and Learning for Equity and Justice in Schools

Encouraging the political activity of educators promotes a continual and developing analysis of socio-political processes to drive connected action. Further, engendering the political activity of educators can potentially facilitate a development of connections between contexts of diverse struggles against globalized forces of exploitation. Political activity is an individual and a collective process and is informed accordingly by social dynamics. As an example, in 2020 racism in the US had been categorized as a public health issue by the American Public Health Association in connection to a surge of activity in racial justice movements after police killings of Black people across the country (*Racism and Health*, 2020). While many teachers are predominantly from white and middle-class backgrounds, teacher education programs have done little to address and prepare educators to acknowledge, teach about, and organize around deeply historical dynamics. According to Ukpokodu (2007),

> Classroom teachers are directly linked to the quality and equitable delivery of education and student academic achievement (Ayers, 1998; Darling-Hammond, 1997a; Flores-Gonzalez, 2002; Kozol, 1991; Ladson-Billings, 2000; Nieto, 2000; Marzano, 2003; National Commission on Teaching, 1996). Unfortunately, studies indicate that prospective and inservice teachers who are predominantly White, middle-class, and monolingual (Futrell, 2000; Kailin, 1999) lack the knowledge, skills, and dispositions needed to successfully work with urban students (Gay, 2000; Haberman, 1991; Smith,

1998) (pp. 8).

She outlined several ways that teacher education programs poorly prepare future educators. For example, there is a pervasive framing of assimilationist ideology in teacher education. Also, there persists the dominance of behaviorist thinking in regards to teacher socialization (i.e., teachers serve as a non-agentive technocrat). Additionally, there is a lack of faculty commitment to multicultural education, and a failure to open the gates of teacher education to diverse teacher candidates. These are just a few of the ways Ukpokudu situated the deficits in teacher education.

While schools and classrooms are a microcosm of society (Popkewitz, 1981; Taylor, 2013), science teachers are centrally located in this struggle. Schooling and science education are essential in (re)creating social stratification of people and the conditions needed to sustain and improve human life (Bowles & Gintis, 2011; Levins & Lewontin, 1987). Science educators continue to systematically disconnect disciplinarily prescribed learning to social and historical contexts (Bianchini & Solomon, 2003; Cross & Price, 1996). A more technocratic view tends to permeate science teaching and learning as science in schools is overwhelmingly positioned as a decontextualized instrument of change, with established unquestionable tenets and as a neutral arbiter of facts. Teachers, particularly science teachers, could be encouraged to develop their politics, in relation to issues previously mentioned, and then consciously connect their practice (individually and collectively) in accordance to their analysis.

Connected Histories and Directional Activities

While science and scientific thinking have developed in diverse ways globally (Aikenhead,1996; Mutegi, 2011; Wang, 2016), we denote science in schools to indicate Western Modern Science (WMS, Strong, 2017), which historically emerged during the Enlightenment period in Western Eurasia. This particular historical form of science is most prevalent in school, curriculum and academic scholarship today. WMS (Strong, 2017), as a discipline, has been characterized as a discipline of systematic inquiry, discovery, innovation, creativity, and freedom. The Enlightenment period in Western Eurasia also marked a struggle over power and production from established institutions (i.e., The Catholic Church and monarchy) to individuals outside these organizations (i.e., knowledge of physics and Newton, etc.). Through this struggle, existing structures subjugating the development of knowing, in the Church, weakened and boosted the "individual" as knower. Simultaneously, WMS enmeshed as part of knowledge-making activities and an ideology in capitalist development developed to subjugate and categorize humans and land in this struggle over power and production. Currently, science education and the science industry, deepen and reproduce WMS, continuing to differentiate and track people in society (Mutegi, 2011).

A historical view into epistemological struggles can be useful to weaving a richer understanding of our educational system in the United States. Schooling is intricately connected to the dominating mode of economic development (i.e., industry or corporate interests) and social relations. The education system and public schooling in the United States evolved from a history beginning with a European invasion and subsequent colonial expansion in the Americas. Historians of education (James, 2004; Kaestle,1983; Perlstein, 2004; Tyack, 1974; Zinn, 2005; Zion & Blanchett, 2017) associated divergent class, gender, and race interests with the project of public schooling. While various legal and labor mechanisms (i.e., private property ownership, company towns, industry linked tenement and tenant communities) operated and dispossessed particular groups of people, schooling developed in a manner that facilitated and maintained

these mechanisms. For example, structures of and curriculum in schools reinforced a protestant work ethic, tenets of hard working, saving, and modesty (Blaut, 1993; Calderon, 2014; Dunbar-Ortiz, 2014), in the efforts to "unify" the State. These curricula targeted racialized communities differently and deepened divisions according to race, class, and gender such as through Indian boarding schools or anti-literacy laws of the 1830s charged against people from an African diaspora (Charron, 2009; Williams, 2012). What developed in this political context was multiple forms of schooling, from Bible recitation coordinated in a one room schoolhouse in European immigrant communities, to the underground resistance of literacy teaching in African diasporic communities, or the violence on indigenous children at the Indian boarding schools (such as Carlisle School) (DeJesus, 2016; Estes, 2019; Fisher, 2008; Tyack, 1974).

The legacies that reinscribe inequity permeates today in many ways such as through differentiation of who learns what kinds curriculum and under what conditions. Today, we can attune to these variations of struggle in initiatives of behavior management systems, uses of developmentally appropriate curriculum, and even differentiation into college and career readiness trajectories. While effects of climate change have become detached from a grounded understanding of racism, the importance as a teaching topic has never been more urgent. This legacy also informs a situatedness of science curriculum and "settled" trajectories in schools (Bang et al., 2012). By far, science education, like all of education, is not politically neutral (Boisselle, 2016) and a deep understanding of a history of uneven development (Marable, 1999) in the country would emphasize that.

Theoretical Framing

In this section, we outline two frameworks, personhood and dialectical materialism, which shape my premise to engender the political activity of science educators. We draw upon theories of personhood (Stetsenko, 2012) to explore teacher identity and notions of becoming. Dialectical materialism brings forward a premise concerning social change (in this case the development and use of science education in society) and offer an engagement with substantive positions regarding what is real and what we know.

Personhood: Connecting Activity, Positionality and Identity

As this research engages the development of teacher identity (Jackson & Mazzei, 2012), we examine this through a concept of personhood. Personhood, in brief, is a framework that addresses "the sets of ideas about what constitutes humanness, how people come to be the way they are, and what makes each person unique" (Stetsenko, 2012, p.181). There are a range of responses to these questions drawing from evolutionary psychology (evolutionary inherited genetic program), cognitivism (or internal information processing), or behaviorism (mechanized reactions to external stimuli). However, we draw upon a different approach to personhood. Stetsenko's work resituates an understanding of personhood in terms of social change and activism as formative and integral to human nature. This particular approach differs in that it counters ideologies that humanness is primarily about adaptation to the world and existing structures. In forwarding this approach of personhood, we further an analysis that each educator can actively seek transformation in an inequitable world through political activity.

Acknowledging the positionality of an educator is essential to engaging in political activity. Positionality refers to the multiplicity of social markers, such as race, ethnicity, economic status,

and gender that are essential to understanding ways they intersect and inform the development of teacher identity. Positionality denotes both one's social location as well as consciousness regarding the social process of teacher identity development (Nasir et al., 2012). Avraamidou (2016) defined identity as, "the ways in which a teacher represents herself through her views, orientations, attitudes, emotions, understandings, and knowledge and beliefs about science teaching and learning" (p. 826). While each educator engages in a dialogue from their own social location, they articulate their awareness, or lack thereof, of their positionality, in a conversational snapshot—as educators continue to shift and develop.

Examining educator positionality gives insight into the specific theories of human development and change (such as cognitivism, behaviorism, constructivism, among others) that teachers leverage in their activity and teaching practices. In taking forward personhood as part of a collective social practice and activity (Stetsenko, 2012), we emphasize that educators are situated as "humans come to be and come to know – each other, themselves and the world – while transforming their world whereby they collectively create their own life and their own nature" (p. 10). Personhood, positionality and activity are connected to a Transformative Activist Stance (TAS; Stetsenko, 2012). While educators articulate ideas and practices, it is but one moment of their process of becoming. As Stetsenko (2012) stated, "this being-through-activist deeds require that we develop a compass about our location in the ongoing flow of transformative collaborative practice" (p. 15), a viewpoint offers an opportunity to gauge political engagement and lay bare the directionality of educator activities. In other words, the concept of personhood is essential to grounding political activity.

Theory of Change: Contradictions and Dialectical Materialism

In addition to personhood, we draw upon theories of dialectical materialism, an onto-epistemology premised on the notion that social and material conditions are in continuous motion and development. Transformation of society emerges in contradictions and explicitly engaging contradictions provides a basis to link learning and social change with power and politics (Au, 2007). Contradictions can be recognized as two interrelated and opposing relations that animate an ongoing feature of change. One way to make sense of contradiction is to consider this term as related to cognitive dissonance—which refers to a misalignment of two different mental perceptions for one person. Cognitive dissonance is often framed as an internal mental process (Ciccarelli & White, 2017). When referring to contradictions on the other hand, we can consider these perceptions, however, one must center the material and historical realities as the grounded bases informing an analysis. One example of contradiction is the relation between positive and negative integers as they are both interrelated (in its formation itself) and in opposition to one another. Another example is the relation between billionaire-owners and precarious labor, often times referred to as the 99% (DiSalvo, 2013). This particular relation is certainly one of opposition as the wealth of billionaires are built from the exploitation of labor of many. This opposition that is the basis of the contradiction has erupted in particular and prominent ways. For example, at this time of a global pandemic, many people (in precarious labor) have been unable to work and receive wages due to social distancing measures. At the same time, the pressure to pay rent and mortgages to landlords and financial institutions remains while there is increasing organizing to demand the cancellation of rent and mortgages. The contradictions between have intensified in these evolving conditions and continue to propel aspects of change. From this basis, contradictions are the basis of political activity. We seek to draw attention to political activity through this framing in order to highlight the acts of educators

engaging contradictions between social and material conditions in communities with ideological and theoretical activities.

Analyzing relations of power over what is produced through human labor and the Earth is political and essential to movements that forward stances to sustain and improve people's lives (ending climate change, Black Lives Matter movement, defund I.C.E., abolish the police, etc.). We locate political activity as decisive acts connected to consciousness of this developing social process. Politics is not a *thing* but is an *activity* of struggle.

The term political is conjoined with activity to connect a concerted practice of struggle. As such, political activity is also both an individual and a collective process. This activity can be enacted in particular places such as classrooms, auditoriums, or even libraries and are related to longer histories.

Methodology

As a research group, we solicited participants for the Informal Learning Environment and Teacher Education Study (ILETES) from New York City educators who had taken part in professional development initiatives on informal science education at an urban science museum. The primary objective of this multi-year study was to examine teacher identities and its relationship with informal science teaching practice. Avraamidou (2014) talks about teacher identity as, "the ways in which a teacher represents herself through her views, orientations, attitudes, emotions, understandings, and knowledge and beliefs about science teaching and learning" (p. 826). From this, the research examines the ways personal and professional histories, institutional structures and teacher education experiences intersect with teaching practice. We sought out public school science educators who had taken part in an urban museum-based science education professional development program and who were currently working in 6th through 12th grade classrooms. We utilized pre-interview questions to be able to get a general sense of their teaching and professional development experience. We also developed our protocols using a grounded theory approach (Charmaz, 2006; Creswell, 2014) and identified questions for a dialogic interview that was informed from our own experiences and practices as K-12 educators. Grounded theory is an inductive method where interviews were subjected to iterative rounds of meaning making and analysis (Charmaz, 2006). In addition, we drew upon the scholarship of Jackson and Mazzei (2012) with our positioning and analysis of interviews to avoid the risk of "when participant 'voice' is presented as an expression of 'experience' devoid of context" (p. 745).

We interviewed approximately twenty teachers for about one hour each. Each interview was transcribed, individual analyzed and then became a focus of a collective analytical discussion during numerous research meetings (Harvey, 2015). As part of a grounded theory approach, each co-researcher had the opportunity to relate their theoretical insight of specific interviews and assert emerging questions to the group. This process afforded an opportunity for independent coding and analysis as well as a collective engagement with the data set. Mazzei and Jackson (2012) forward, "a fostering of methodologies that dwell on the complications and troublesome voices that indeed do not ascribe to hegemonic discourses and knowledge claims" (p.746). As a result, we opened our viewpoints to examine a wide range of positions and theoretical stances.

Analysis

Through an iterative analysis of the interview set (Charmaz, 2006; Jackson & Mazzei, 2011; Knight & Saunders, 1999), we examined the political activity of teachers with a focused attention to teacher's vocalized positionality and practice concerning contradictions between science education and their students' lives. Contradictions are a consistent feature of change and can be characterized as two interrelated and opposing relations that animate it. The following questions shaped our engagement with the data.
1. What are contradictions of science education that is connected to schooling?
2. How does the educator's political activity present itself within a formal (official) curriculum? or in informal practices/pedagogies (hidden curriculum)?

Bearing in mind that teachers are in "unbreakable, intricate connection with the world … [and as such human] beings need to be understood as an indivisible and seamless, unitary (not composite) process of humans engaging with their world, the totality of life" (Stetsenko, 2010, p. 83), teacher interviews provide strands to pursue as one facet their activities and ideological conceptions. Avraamidou (2014) noted "teacher learning and development are viewed as a process of identity construction through social participation" (p. 825). Identity, as related to and informed in social participation, transforms in an ongoing process. Thus, teacher identity, grounded in notions of social participation, and science education do not exist independently of socio-political forces in society (Mensah, 2016). Extending from this premise, an individual, an object (science education) or teacher identity (via social practice) can be recognized as a political entanglement in social relations. Each articulation of social participation along with a broader context ought to be made clear in order to appreciate the different positionings, of informal or formal science, in teacher comments and interpretations.

In an effort to examine political activity, we connected broad historical and social forces with vocalized knowledge and ideological positions. In other words, political activities are ascertained by teachers' vocalized position and practice as they relate to contradictions between science education, schooling, and students' lived experiences vis a vis social location.

As we engaged with the interview set further, we continued to develop more inquiries from the conversations.
1. What do teachers' descriptions of and dialogues about informal or formal science learning, curriculum and schooling reveal about their ideologies and social practices?
2. How do teachers problematize the purpose of science education and society adjusting stance, positionality, subjectivity and teacher identity?
3. In what ways do these revelations connect to (historical, agentive subject) history, power, and social relations within the institution of schooling?

Listening to Silences

In each interview, we found that we attended to both articulations, as well as the silences (Entigar, 2020; Kawabata & Gastaldo, 2015; Poland and Pederson, 1998). Silences were sensed through symbolic exchange, pattern of talk, and noted omissions of speech as silence "not only to describes the natural and social world but to construct and regulate social subjectivities and relations, to articulate and embody particular forms of difference, and to construct and cultivate particular reading, writing, and speaking practices and positions" (Luke, 1995, p. 21). Additionally, silence bestowed a vantage point into other-worded notions (such as in the

vocalized expression conjoining ambiguous statements, "You know?"), inferences within particular social and cultural contexts, and purposeful omissions.

Developing a Tool for Reflexivity

Between the interviews and literature, we rendered a heuristic to offer an engagement of reflexivity. This heuristic is not meant to serve as a deterministic evaluation or static state of individual educators. Rather, our intention is to widen our view of science teacher articulations and enactments—calling attention to the constant intervals of time and support necessary with respect to politicized transformative activist stance. Classroom conditions are connected to social conditions and is represented in the spiral of the heuristic:

> I am, I'm dynamic. I change up really quick. Like once I see oh, this part of my lesson plan is not working, my mind it works quick and I'm like ok, here is what we are going to do… and it might not have been in my lesson plan, but I see that it is going to help for them to get that better understanding. So, I'm dynamic with it, yeah…Structured and flexibility, exactly (8th year teacher).

This educator notes that teaching and learning are constantly in flux and conditioned in the classroom environment. Classroom conditions are also intimately connected to social conditions of students' individual lives, the history of the school community, and broader political economy (Anyon, 2006; Oakes, 2005). Science educators, scholar-activists, teacher educators, educational researchers and all learners must recognize that in our current education system particular lives continue to be sustained while many others are violently and systemically incapacitated (Laura, 2014; Patel, 2015). Teachers can be prompted to engage in a reflexive engagement with their political activity, and consciously connect this to their teaching practice in accordance to their unfolding analysis.

Figure 1 below conveys relations between historical relations, educator, personhood, and collective social practices while also functioning as a heuristic.

Figure 1

Heuristic for Reflexively Examining Political Activity

Reflexively Examining Political

Fleeting — Dismissal

Enduring — Refusal
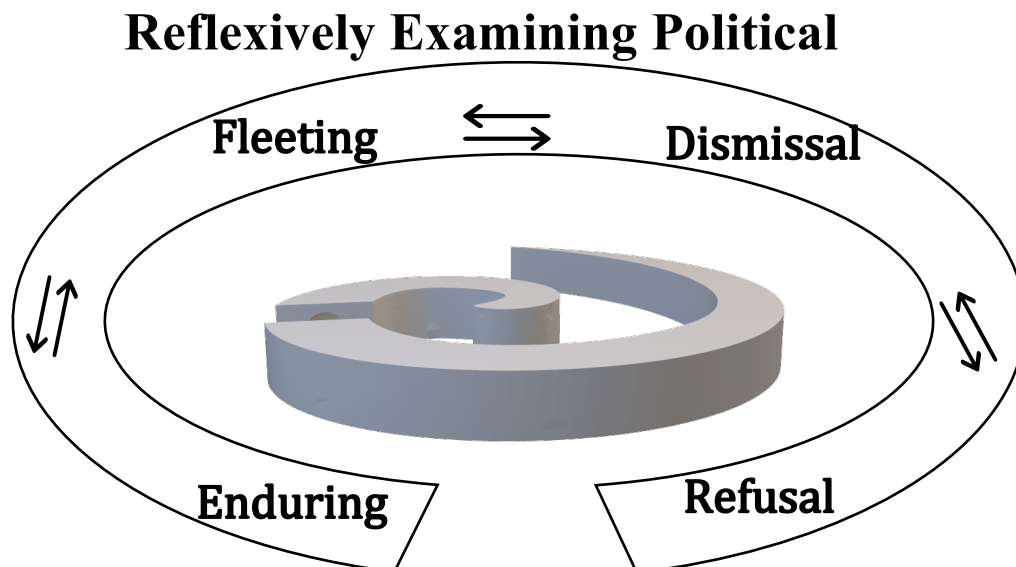
The middle spiral in the graphic signifies connective and constantly moving historical relations. Articulations and silences, in the form of inferences from teachers' articulations, are positioned in relation to this middle spiral. Each term on the arch in the graphic distinguishes both the *frequency* and the *voracity or emphasis* of analytical statements from which political activity is noted.

Enduring indicates that there are overt and **substantial** indications of vocalized (in speech or silences) contradictions between science education, schooling, and their students' lives, including an analytical reflection of immediate circumstances, as it relates to broader social-historical processes. Fleeting indicates that there are **elements or wisps** of vocalized (in speech or silences) contradictions between science education, schooling, and their students' lives, analytical reflection enacted of immediate circumstances, as those relate to broader social-historical processes. Dismissal and refusal indicate a range of expressed **opposition to connect** or view contradictions between science education, schooling, and their students' lives. This includes a refusal for analytical reflection of immediate circumstances as it relates to broader social-historical-political processes. In instances of dismissal or refusal, a deep historical inquiry in the material and social relations of communities and school can be undertaken. The arrows on the graphic also mark that political activity is dynamic and is therefore possible to organize and shape.

In each interview, using a collaboratively developed protocol, teachers conversed about science education in their schools. They were asked to share their definitions of informal science learning, describe their students-learners, reflect upon their teacher identity, describe good science teaching practice, and convey their school structure. We dialogically engaged with their notion of informal science learning from variety of angles (in relation to how they described students or to how they described good science teaching practices). From these conversations, we clustered teacher responses into a several themes that bear relevance to instances of political activity.

Relating Teacher Quotes to Heuristic

We categorized political activities from teachers' vocalized position and practice, in speech and through silence, concerning contradictions of science education, schooling, and students' lived experiences vis a vis their social location. Each table shares quotes that demonstrate the noted frequency and emphasis of political activity, enduring, fleeting, dismissive, and refusal, that is represented in the arch of the graphic above. The chosen excerpts highlight a range of articulations as teachers examine the role of a teacher in learning.

The teacher responses in Table 1 that demonstrated enduring political activity positioned the role teachers as teacher-learners and students as learner-teachers. A teacher's role was acknowledged as centered around their students and an on-going part of their teacher development. In these responses, teachers articulated a deep reflexivity – constantly questioning and reevaluating their role in unfolding situations of learning. They revealed that they were also actively engaged and present in innovating approaches to learning considering contradictions of curriculum and student-community concerns.

The politically engaged part of the heuristics are articulated in educator's enacted activities/ideologies. One science educator noted a particular engagement with the political as a social process. In their statement, they acknowledge positionality of the educator and power as part of the classroom and society:

So, I think all of that puts me in this place of understanding that students don't really care about how smart you are. They need to know that they can be smart too, and the only way to get them to know how cool the stuff I know is, right? Because before, there was a time I didn't know it. Right? Um, is by having an experience (10th year teacher).

Table 1

Excerpts Indicating Enduring Political Activity

	Enduring Political Activity		
Role of teacher in learning	I feel like, I **don't care if I have been teaching for 15 or 20 years, there is always more for me to learn.** Because each successive generation of students, each successive group of students that come in is different….So, I learn from my students also. I often check in with them and get feedback from the students as well. (9th year teacher)	I do think a lot about the connection to the real world, for these kids. You know what I mean? So, I feel more pressure this year to teach to test. Which I can't stand. I hate the Regents more and more each year. But I always try to connect it to their everyday experience. And I try to have discussion a lot about whatever it may be. **If the kids are curious about something I put time into discussing whatever it is that they are curious about. You know what mean regardless of whether or not it is in the curriculum.** (2nd year teacher)	I treat them the way I want a teacher to treat my three children. So, I'm a teacher that is concerned with not only their academics, I'm concerned with their social, their emotional, their spiritual if they feel they want to discuss that, their spiritual needs, you know. So, describing myself, I educate to the total child. You know, even in terms of their morals. You know, I can't force my morals upon them, but at the same time, that is disrespectful, I don't appreciate that, you will not treat me that way. **I always treat you with respect. Don't I speak to you with respect?** (8th year teacher)

This educator highlights a tension between the positionality of an educator and markers of teacher identity that connect with socially constructed notions of legitimacy, such as smartness. This educator also notes that this preoccupation detracts from the desires of students who seek to develop their activities of knowing and doing. Further, the designation of smart, as a product of schooling, recreates associated hierarchies endorsed through practices such as tracking (Leonardo & Broderick, 2011; Oakes, 2005) and reifies a top-down conception of one's humanity (Wynter, 2003). However, this educator alludes to questioning and knowing that power is designated to these institutionalized notions of smartness. Additionally, this positioning of smartness has been contested by educational theorists' assertions of education and learning. One example is in Dewey's proclamation in which he elevates learning as experience in life (Dewey, 1916; Dewey & Small, 1897). Statements in Table 2 that indicated fleeting political activity showed elements of analysis of political and historical struggles concerning the purpose and control over curriculum and knowledge production particularly in regards to the 'what' and the

'how'. Educators positioned that teachers remain as primary knowledge keepers, even if there were divergent views regarding sharing and assessing forms of science and knowing. While some excerpts indicate a desire for reform in education, more often educators with fleeting political activity maintained that the role of the teacher was crucial to teaching virtues of good scientific practices and work practices, aligned to a bootstraps work ethic.

Table 2

Excerpts Indicating Fleeting Political Activity

	Fleeting Political Activity		
Role of teacher in learning	Like, I was in a **different generation** of like...The teacher taught, the kids took notes, you had a test that was based on what you learned, and **it was very straight forward**. I think it's a lot more um, it's a lot less straight forward now. Because **we want** kids to think and discover and create and be critical and that's actually really hard to do. (4th year teacher)	It's really focused on literacy and incorporating literacy throughout all the subjects. We learned about science literacy which was great. I see the need for that, but I also think science really lends itself to STEM and engineering and incorporating math more in science and not only just writing and writing essays in science. I think students miss a lot when they don't have time to do the hands-on and engaging stuff. I see with their point, but I think it's almost like, a little, you know, too much, and that science really, you need to have those experiences and get those hands-on, practical skills and knowledge. It's hard to **find a balance with that when you have such a limited amount of time with the kids and you have to cover so much in the curriculum**. (9th year teacher)	Like from being there for kids and then I get them to do the work. I also tell them if they fail a test you can write out any questions you got wrong, kind of explain the correct answer and then they get a half point. You can't fail an exam because like the point of view is to learn it. You know if you didn't get it the first time, that's fine, but as long as you show me you can now know what you are talking about, that's what matters. I don't know how to share that but I give a lot of second chances and leeway and try to be supportive. (6th year teacher)

One science teacher shares an activity in the form of an on-going conversation with school administrators to develop and offer an extra class, outside the standard classes offered, centering

experiential learning and informal science methods as part of the school curriculum. The following quote exemplifies school-based struggle regarding control over curriculum, and specifically, from an experiential investigation of ideas which tend to be less standardizable across place.

> Oh, we want to do like, this activity with the kids, and we want to have a class. She [the principal] wanted it to be well thought out and that the kids are learning, you know, specific skills and things like that. It's also something that we do. It's an extra class. So, me and my colleague, we have two less preps than everybody else. Um, because we are teaching *this* class. So, it's on top of our regular schedule we had to like, fight for it because the principal didn't, you know, really understand it at first. Again, like I was saying before something I learned from my professional development, but something that's, my school wasn't necessarily like, on board with or something that they thought was important. It was kind of like, a lot of convincing as to the benefits of this type of class and, we had to like do research on it and present it and kind of write a whole like, report about it. That was the approval process. (9th year teacher).

This quote gives a particular viewpoint into issues of control over science curriculum. There are long-standing disagreements concerning how school science should be taught—as an accumulation of base line facts and unquestionable truths, or as an interdisciplinary interconnected exploratory practice (Amos & Boohan, 2013; Barab & Luehmann, 2003). Moreover, this conversation takes place within institutional confines, as the teacher remarks, and concerns maneuvers of control over how science teaching and learning are carried out. Another layer that informs the dynamics in this example is science learning standards and practices (i.e., Next Generation Science Standards or NGSS). The NGSS are the current iteration of science educational reforms and standards that work to decentralize a focus on teaching de-contextual scientific facts and emphasize rich cross-disciplinary content and practices (Adams et al., 2020). While this broadens possibilities in science teaching by making issues of equity more visible, emphasizing a less is more approach to curriculum, and highlighting learning progressions (Clark et al., 2020; Rodriguez, 2015), these reforms also reproduce the uninterrogated assumptions concerning positivist evidence-based approaches to science centering modernist scientific testing and evaluation. Further, regimes of standardized testing directly influence teaching to focus to a fixed body of memorizable facts as testing scores continue to be a powerful form of influence, particularly with punitive measures of accountability in learning. Even though science standards can be flexibly addressed in schools, they currently continue to reinscribe barriers (varyingly enforced by administrators, corporate test developers, and policy makers) to developing learning environments that encourage making connections between social problems across communities.

Responses in Table 3 exhibiting a dismissal of political activity expressed disconnection between their work and the role to broader situations in society. Some teachers expressed reverence to a past of "straightforward" education, implying that this particular moment is divergent and deviant from the status quo. Teachers also communicate a distancing to their decisions in shaping conditions for learning. This is noted with the teacher who frequently asks another educator whom she sees as more connected with her students (racially, ethnically). As teacher preparation lacks the development of educators' engagements concerning equity and diversity, as highlighted in Okpokodu's (2007) research, each excerpt demonstrates a lack of examination of teacher positions resulting in maintaining a relation between teacher and student that re-creates previous ways that the construction of schooling has been shaped by dominant

political economic interests (i.e., Lancasterian system). Tyack and Tobin (1994) related the varying political interests, organization, and experimentation concerning structure and function

Table 3

Excerpts Indicating Dismissive Political Activity

	Dismissive Political Activity		
Role of teacher in learning	Science is asking questions and seeking answers to a methodical method. Looking at other people's research. Which **I don't think necessarily 12-year old can do. 100% of the time they need some of like the answers**, well like the definition of whatever it is, is this. I think that they are more engaged when there are questions for them to answer. Like a puzzle. (2nd year teacher)	I'm aware that some of these kids are going to college and some of them are interested in science. Some of them are not even interesting in applying to college. I feel really torn because there are people who I go to, who I ask for help and they say, well as long as you keep them interested and engaged you won't have behavioral issues and you'll have like maximal class enjoyment. Then there are other people who say my job as a 12th-grade teacher is not to push the content so hard but reinforce skills that they are going to need in college, wherever they end up next year. (1st year teacher)	The biggest resource I have is the math teacher that I work with right now. She just has that, she has it. I think the kids probably relate to her a little bit more because she can be like their grandmother. I'm like the one single white person in the classroom so they see me as an outsider. She is frequently telling me like what she does, when she has these problem groups. She also used to teach science. So, she really, like if I'm doing something hands on, I'll bring it to her and be like ok, so what do you think of this? And she will start giving me ideas. (3rd year teacher)

of schooling from the origins of the Carnegie units and graded school to flexible high school models implemented in the 1960s. They underscore a point that "the grammar" of schooling could change if people are committed to a continual and deep public engagement with purposes, ends, and means of schooling. In this way, the teachers' articulations demonstrate a profound disconnection to a dynamic history of education.

And lastly, responses in Table 4 that indicated a refusal of political activity often included statements that suspend students in terms of development to enact, take up, and innovate knowledge. Participants positioned that educators remain as primary knowledge keepers even if there were divergent views regarding sharing and assessing forms of science and knowing. Statements highlight individual responsibility (or rather irresponsibility) to learning that is devoid of context and political histories, while also maintaining an unyielding hierarchy of learners (i.e., excellent test takers are more responsible for their learning). These statements echo the enduring ethos in a "colonial education system, [where] learners are constantly assessed as a

measure of academic achievement, prioritizing intellectual learning objectives and banking-model styles of pedagogy as indicators of success" (Marom, 2019, p. 331).

Table 4

Excerpts Indicating Refusal Political Activity

	Refusal of Political Activity		
Role of teacher in learning	I wanted to make units that are centered around diseases that are maybe more prevalent in certain populations. There is a higher prevalent of diabetes among Hispanics and most of my student population is Hispanic. I kind of contextualize nutrition and learn about homeostasis and feedback loops with the pancreas in the context of diabetes and its high prevalence in the community. I kind of felt like I failed at the end because I felt like I didn't know, like, I don't know that I would write about student's experiences with something in their community and whether that would affect their behavior? We talked about how diabetes is linked to diet and I was impressed that my students. They were very informed about that. They had background info on the American diet because of their environmental science class from the year before. They were pretty knowledgeable about food and food deserts. (1st year teacher)	I went through a period where I wasn't being judgmental about it, but because I am not in their shoes, but now that I have my own kid, I am judgmental about it because I don't, I don't think, there is just no excuse for being that, unevolved. Like, I understand not being there for every meeting, but there is no excuse for being that unevolved. And that really interfered with the student's learning. They don't, they don't do their homework. There is no, like learning happening outside of the classroom. (3rd year teacher)	In the beginning of every design challenge unit, I gave them three examples of machines that have been invented to combat some aspect of pollution or litter. What do you think of these? Which one do you think is the best? (4th year teacher)

Additionally, these statements uphold a construction of normativity centered on Western ways of knowing or Western modern science and maligning "Othered" epistemologies, knowledge systems, history, language and practices.

Racist and class ideologies are also present in other ways. For example, the "Hispanic community" (referenced above) is named, characterized as homogenous, and also characterized without mention of a historical context particularly in relation to food sovereignty. In addition, a

deficit notion of students and community underscores these excerpts. The role of the teacher in these instances would be to manage instruction in a manner that reifies existing systems of tracking and developing mainstream (aka capitalist) work ethic. Teachers reveal uninterrogated understandings of learning, the communities in which they work, and varied processes and contexts of learning.

Each of these tables and analyses take into consideration instances in the interviews. The excerpts are not a summative assessment of an individual teacher, but rather provide insight into a broader take on developing science teachers and politics. As such, individual teachers in this study communicated responses that could be placed along varying parts of the heuristic. On the whole, political activity in struggle, is not a *thing*, but rather developed as a process through activity, both individually and collectively.

Educator Roles in Onto-Epistemological Struggle

The excerpts have wider implications concerning the role of a teacher and science teaching. From a standpoint of personhood, teacher articulations of social location in relation to science education needs to be linked to socio-political forces in society. As previously noted, political refers to one's activity in relation to recognizing one's "positionality" as associated to power in a social process. Contradictions emerge from these statements as they are observed alongside a longer history and development of schooling in the United States as well as to a particular development of science as a powerful discipline. We return back to the questions we initially articulated from observing concerted efforts to demand action towards climate change: How does political activity come to fruition? How do students and educators come to examine, know, and act upon climate change, as if the world is literally on fire? What are the articulations, stances, and practices of educators, particularly science educators, in this process? The statements each educator made are not a static notion of their place but more of an indices to consider as educator-organizers-activists work to rally sustained work to these ends. Further each statement serves to highlight the range of political analysis around who produces knowledge, or who consumes and (re)produces knowledge. Let us look back at historical markers and echoes from a connected past, that would inform a purposeful development of political activity.

Echoes of Connected Histories

Insight into epistemological struggles in the United States can be useful to weaving a richer understanding of our educational system and science teaching and learning. Schooling is connected to the dominant mode of capitalist development (i.e., industry or corporate interests) (Anyon, 2006). The education system and public schooling and related policies in the United States also continue to differentially impact communities in relation to class, gender, and race (Picower & Mayorga, 2015). Structures of and curriculum in schools reinforce a bootstrap's work ethic (Calderon, 2014; Estes, 2019) and value particular forms of innovation and creativity (Boisselle, 2016; Mutegi, 2011) in the efforts to "unify" the State. These curricula target racialized communities differently and deepened divisions according to race, class, and gender as happened in Indian boarding schools or through anti-literacy laws of the 1830s charged against people from an African diaspora (Charron, 2009; Williams, 2012).

We must explore diverse approaches of teacher instruction and the role of the teacher along with the multitude of efforts to centralize, maintain, or wrest control over structure of schooling

and curriculum. Teacher instruction varied across communities in American history, from the direct instruction of reciting Bible passages in European descendent settler communities to the clandestine political resistance of literacy teaching practices by people of African descent who had been enslaved known as stealin' the meetin' (Robinson, 2020). As the economy in the United States became industrialized (i.e., factory production), so did the system of education, particularly in northern cities, with the Lancasterian (Tyack, 1974) system, characterized by the structure of hierarchy of roles/authority, much like in a factory. By the early 1900s, progressive constructivist and experiential modes of learning were promoted by Dewey and other contemporaries. The legacies from this history, re-forming inequities, permeates today in covert and overt ways such as in initiatives of behavior management systems, uses of developmentally appropriate curriculum, and even differentiation into college and career readiness trajectories. This legacy also informs a situatedness of science curriculum and "settled" trajectories in schools (Bang et al., 2012). Science education, like all of education, is not politically neutral and a deep understanding of a history of uneven development (Marable, 1999) in the country would emphasize that.

School reforms converging on struggles over curriculum and pedagogy impact the perceived and enacted roles of teachers in learning. The aforementioned historical tendrils continue to shape the conditions of political activity of teachers, along with their own analysis and activities regarding who controls and produces knowledge and for what purpose. As global economic production has become increasingly differentiated such as in an Uberisation (Bruce, 2019; Hall, 2016; Nurvala, 2015) of service-related labor (gig based work with zero social security or benefits) to Silicon Valley development of digital and surveillance technologies to mining of precious metals used to build particular technologies, a connection to a critical historical and political analysis in science education to the kinds of knowledge and desirable skills is crucial.

Conclusions/Implications

Teacher education programs and science education programs, on the whole, have not sufficiently acted upon the potentialities to promote political activities as connected to personhood and human development (Ukpokodu, 2007). This becomes evident as teachers articulate their political analysis and enact a range of teaching practices within a context of re-forming educational initiatives. Yet, an analysis of interviews shows that while articulating their understanding of informal science teaching (something outside the status quo), teachers can be encouraged to connect and cultivate a politics of knowledge production to curriculum, pedagogy, and schooling (Sondel et al., 2017).

As science teachers, teacher educators, and educational researchers, there are a variety of ways that personhood, positionality, and the politics of science education emerge in a protracted struggle for just world. One way of engaging is in developing politicized consciousness and practice as an ongoing process. Another is in iteratively interrogating assumptions that take for granted ideas of what is true and real. The role of a teacher can be grounded in intentional, critical, and open analysis that is connected and responsive to an expansive understanding of learning and living conditions.

Some emerging implications from this analysis include a push to school leaders, teacher educators, and teacher leaders to cultivate and create spaces where the political activity of science teachers is intentionally developed. Similarly, all educators who engage in teaching and learning need to investigate assumptions which are taken-for-granted (this means you, dear

reader). We must recognize that developing and nurturing political activity of teachers is ongoing.

Finally, explicitly linking science teaching and learning to political activity does not mean that regressive ideas in learning (i.e., climate change is not occurring) will cease to exist. However, by moving from a firmly historicized and politicized understanding, we can approach each trending pedagogical and curricular elixir as surfacing in existing contradictions under school reform. Schooling is more than what happens within four walls or under the direction of educators, administrators, and budgets. It is a site of on-going social resistance and struggle. Let's learn from climate activists who teach us to change the world as if it is on fire.

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