Critiquing and Transcending STEM

MATTHEW WEINSTEIN

University of Washington, Tacoma; Email: mattheww@uw.edu

Responses

JASTE is a non-refereed, open-source, journal. We encourage reader feedback on contributions to it. Please send your comments, suggestions, etc. about this paper to Matthew Weinstein. Thanks!

ABSTRACT

This paper examines STEM (Science, Technology, Engineering, and Mathematics) as a form of neoliberal governmentality. It looks at the NGSS as a vehicle for a particular entrepreneurial subjectivity. It also examines the repression of earlier forms of scientific subjectivity. It then moves on to consider both the strategies teachers can take to resist neoliberalism more generally and STEM specifically. It resists suggesting alternative curriculum, but instead focuses on the role of teachers collectively working to change the material conditions of schooling. Finally, the paper considers what science education might look like in a post-neoliberal state.

May 2016
INTRODUCTION

In this paper I outline a critique of the idea of STEM (Science, Technology, Engineering, and Mathematics) in education, focusing on its rather creative articulation to the project of neoliberal economics and governance. I set out some other visions for technoscientific practice that shares some analogous characteristics to STEM in that they trouble technology development and the formal sciences, but focus on economies of justice. Note that I am writing from the U.S. context in which STEM penetrates our lives largely through the newly released Next Generation Science Standards (Achieve, 2014), and much of my critique will be focused on those standards.

NEOLIBERAL SCIENCE EDUCATION

Everybody talks about STEM fields—science, technology, engineering, and math—but no one’s really interested in science, and no one’s really interested in math: interested in funding them, interested in having their kids or their constituents pursue careers in them. That leaves technology and engineering, which means (since the second is a subset of the first) it leaves technology.

—William Deresiewicz, Harpers Magazine, 2015, p. 27

STEM is at a surface layer merely a joining of multiple interdependent technical disciplines. STEM points to disciplines that seem to be of a like kind, characterized by such superlatives as rigor, precision, empiricism, and complexity. And, in some locales the adoption of STEM identity means little more than the addition to the curriculum of an engineering/technology focus: meaning the addition of engineering or robotics in afterschool programs or in Career and Technical Education.

However, in much of the U.S., where curriculum is guided by the emerging Next Generation Science Standards (NGSS), STEM represents something more complex, more reflective of a certain zeitgeist, and more corrosive to the traditional approach of teaching science. In every subject area of the NGSS, traditional science content is extended or infused with engineering—what is termed “design”—logics. This is a dramatic shift in the orientation of science education. Science education has, in the U.S. context, been a mix of catechistic memorization and descriptive exploration and experimentation. The point is to understand and rationalize in a cartographic manner the dissected pig or sheep eye lying on the dissecting pan; it is confirm that objects at rest remain at rest, objects in motion with no net external forces remain in motion. It has not been primarily about designing a “better” eye or a “faster” object. That changes in the NGSS. The new standards privilege an entrepreneurial subjectivity, one that is explicitly linked to engineering identities (Tonso, 2006). Repeatedly students must respond to an injunction to “design” rather than explore, maintain, care, or relate-to, to suggest other injunctions we might want our curricula to perform.

When I say that STEM is of a particular zeitgeist, I am referring to that complex mode of economic being which is generally known as neoliberalism, but often optimistically referred to as late capitalism (on the unwarrantedness of this optimism, see Lilley, McNally, Yuen, & Davis, 2012). Neoliberalism refers to the ideology that markets are perfect information processing machines. Such an axiom means that markets and market-based solutions are theoretically beyond critique, since all critiques must be based on less information than the market itself (Mirowski, 2004). This axiom leads its adherents to a variety of other proposals. Central to these is an understanding of labor as human capital, i.e., that views us all as players in games of capital accumulation (and loss) as we compete with each other for resources including work. It is a social Darwinian landscape in which collectivity is seen as un-natural and the market as producing a perfect meritocracy in sorting out the winners and losers among those capital-bearing players. The axiom also
suggests a policy deregulation, since that is seen as fixing (in the sense of biasing) these supposedly perfect machineries of efficiency. This ideology of markets as perfect information processors puts neoliberal ideology in direct conflict with science, which premises that experimental design, systematic intimacy, and excruciating testing of hypotheses is the surest path to secure knowledge.

I will return and critique this ideology more thoroughly. I just want to indicate how deeply STEMification of science education—not to mention entire schools embracing STEM as a totem—is indebted to this neoliberal logic. STEM education represses the scientist whose authority is based on faithful description as the central icon of the sciences and replaces her or him with the engineer-entrepreneur (and as David Noble notes, engineering education has always been about the infiltration of the corporation into education (1977, loc 63)), who can provide technical fixes that the market place can distribute for “needs” invented or otherwise. In other words, not all solutions will be accepted as engineering solutions. Solutions that focus on (ever inefficient) democratic processes, for instance, do not qualify in this new pedagogy; these are technical systems, not communal ones. In the human capital/Darwinian game of selling ourselves, we all are forced to be entrepreneurs in which we sell ourselves and our work as commodities. Thus STEM education is producing this perfect subject of Neoliberalism, educating “science” students to sell themselves, their ideas, and to see themselves as entrepreneurs (engineers).

But STEM comes to seize entire schools, cities, and even state’s imagination through other neoliberal pathways. As Naomi Klein notes, neoliberalism is also disaster capitalism. It preys on crisis. In part because it is deeply antithetical to any democracy beyond the marketplace, in part because it fetishizes the disruption of older systems as a mode of progress. Crisis is a mode of governance in neoliberalism. As that neoliberal par excellent, Rahm Emmanuel, famously said, “Never let a crisis go to waste” (Mirowski, 2013). Crises are not to be resolved or survived, but fanned and exploited. The so called STEM crisis, in which employers complain in media and through legislation, about the inability to find qualified engineers and technicians, drives transformations in schooling (including the production of the NGSS). Districts quickly reorganize to address the crisis—innovation schools, STEM academies etc.—even though many analyses point to a lack of any such shortages—to the extent they exist, they are regional or in arenas so new and possibly ephemeral, that any attempt to fill them nationally will merely produce STEM enabled un(der)employed. In other words, as happens so often in the wild, under-regulated world of neoliberalism, STEM education is highly speculative, producing a bubble of human capital that, if all goes as intended, will lead to lower wages and STEM students blaming themselves for not having accumulated the right human capital to win the technoscientific game—as things stand only 25% of STEM students go on to STEM jobs (Golod, 2015).

In the U.S. context STEM discourse is very seductive. It is seductive to scientists and teachers. For years, in the wake of the awful No Child Left Behind Act (No Child Left Behind Act, 2001) science has had to play second fiddle to literacy and mathematics education. Now, under the hybridization of STEM, it has a place at the table. But mostly, for teachers (and school administrators at all levels) STEM is seductive because STEM involves/attracts money; lots of money. A perusal of stemgrants.com (2016) on April 25, 2016, reveals the following players funding the teaching of STEM: Google, Toyota, NIH, Florida Power and Light, and the US Army eCybermission (whose competition involves solving “real world problems” using science in teams, which to myself, a skeptical reader, seems like a variant of Orson Scott Card’s Ender’s Game (1992)). I have had graduates of our program call anxiously to let me know their school was being converted to a STEM school, and did I know what one was? And could I advise them? Big money is behind STEM for many reasons: to solve problems cheaply (as in competitions, which basically gamify outsourcing), to swell labor pipelines, and shape K-12 education as a goal in itself.

So what is wrong with this forcing of the new paradigm—since STEM is not so much supporting science as transforming it—onto schools and science more generally as a discipline? The economist Philips Mirowski (2011) notes that the neoliberalization of science has meant in general three things for science: (1) the emphasis on fast tracking research to products (perhaps the most STEMy of the three) and
concomitantly de-emphasizing unexpected results which traditionally have been the fuel for future research, (2) the intensification of property rights including patents and material transfer agreements, which forces institutions to compete and discourages scientific cooperation, and (3) the substitution of market value for empirical value so that junk science can gain the same status as established scientific findings (on this last point also see the discussion of the tobacco industry in Oreskes & Conway, 2010)). The net effect of these three neoliberal transformations in science is a decrease in both the quantity and quality of science carried out, as Mirowski tries to demonstrate through bibliographic analysis. STEM and the market based ideology it represents undercuts core philosophical principals as well as historically central practices that enable science: truth (not necessarily final or singular truth) determined by data rather than markets; the Mertonian norm of communism, and a valuing of deep description that allows the unexpected to be recognized. So neoliberalism hollows science out, removes the practice that has allowed it to blossom.

On the one hand, the new entrepreneurial (often called “translational”) science weakens the foundations of orthodox scientific practice. At the same time the new STEM focus, by claiming a joint identity for technical fields and distancing science from the humanities and social sciences, makes it difficult to ask a variety of foundational questions about science. In the new order (and well reflected in NGSS) questions of ethics within the sciences themselves, the politics of science, explorations of how science enters decision making, activism (beyond entrepreneurialism), and the entire history of science both positive and complicit in the production of injustice and indifference—including racism and sexism—is rendered external to the study and practice of science. By emphasizing entrepreneurial rather than critical and obsessive care, it seems in line with the new entrepreneurial lens, that ethics has disappeared entirely from the standards—where ethics does appear it is tied to engineering solutions, and limited to environmentalism, science’s problematic history of objectifying subjects (not to mention entire races, genders, sexual identities) is nowhere acknowledged, though it did get brief acknowledgement in previous standards.

I do not want to deny the ambivalence of the new standards in regard to the effects of neoliberal policies on science. Yes, the NGSS accepts uncritically the engineered view of science (while noting with some trivial hand waving that the practices of engineers and scientists are somewhat distinct). However, the NGSS pushes back against the market definition of value, insisting on evidence as the arbiter of truth. In line with this, the NGSS is explicitly intended to push back (to give teachers cover, as I have heard proponents express it) against the neoliberal junk science purveyors, esp. the Heartland Institute’s anti-global climate change nonsense and the neoconservative Discovery Institute’s promotion of creationism.

I have focused exclusively on the effects of STEM as mechanism for “managing” and undermining science within neoliberal governance. It is important to understand, however, the effects of neoliberal governance has been devastating for most people—STEM aside. Only the top part of one percent have really benefitted as so-called “free market” policies have been implemented (Harvey, 2005; Mirowski, 2013; Mirowski, Plehwe, & ebrary Inc., 2009; Ross & Gibson, 2007; Wacquant, 2009). Neoliberal ideology has corroded social and civil cohesion as it hollowed out state function after state function for profit. While it opens markets those markets tend to be monopolistic or to produce extreme inequalities in wealth (Cooper, 2008). STEM is one tip of one iceberg in a large floating assemblage that I have called neoliberalism (on the weed like organization of neoliberalism globally, see Ball, 2012). I want to emphasize this larger landscape because in resisting STEM, my deeper concern is with resisting neoliberalism as a mode of capitalist governance, tout court.

At the same time, while STEM as a mode for managing science is problematic, I am not critiquing the breaching of science with other fields (Engineering, Math, etc.) per se. Any teacher of K-12 students knows they must reach outside of science and explore applications and manifestations in the lives of students to make science relatable and interesting. Applications (aka technology) have always been there in some inchoate sense. STEM just makes these breaches of the internalist narrative of science more explicit, but untheorized. Neither the old random example nor the new “engineering everywhere” makes clear the deep
relationships between these four initials. To explore the letters of STEM as more than just aggregate subjects (or worst engineered subjects), it is necessary to turn to those who follow and trace (represent) these subjects as sociological entities: Science and Technology (and Engineering) Studies. It is in the work of Latour (1987) and Callon (1999) that we start to develop models for how and why science and engineering must be entangled within a capitalist system of exchange—though such overtly political critique comes in the wake of Latour’s analysis and largely in others’ works which extends Latour through Feminism, Anti-racism, Anti-colonialism, and political economy (Fortun, 2014; Haraway, 1989; Law, 1991). STEM’s problem is that it is designed to limit articulations of science with these sociologies, anthropologies, and political economies. STEM is a kind of boundary work (Gieryn, 1983) that tries to sever science from its social context and relocate it in service of the market. By recognizing this, an alternative to science as STEM becomes intelligible in the neoliberal fog of human capital discourse.

So to push back against neoliberal perversion of science and science education it is really necessary to start with what it is trying to exclude, to examine those marginalized knowledges that attempt to trace science in its larger contexts. If the fault of STEM is that it elides fields (with the intention of corrupting science), we can still cross those boundaries, but need to open up the topos of science education (i.e., the field that “represents science” in both the political and semiotic senses) to include analysis of science and history (including colonial history), Latourian network theory, and critical understandings of the role of science in both embodying and challenging power (for a terrific history of the ways scientists have challenged power, see Moore, 2008). Only through a curriculum that locates science as institutional, historical, and comprised of human labor can students take an ethical, political, and honestly appreciative stance towards science.

RESISTANCE

Oh the winds, the winds are blowing
Through the graves the winds are blowing
Freedom soon will come!
Then we’ll come from the shadow.
—The Partisan, Anna Marly & Hy Zaret

Challenging STEM involves challenging STEM’s foundations: human capital theory, neoliberal governmentality, and even capitalism more broadly. This broader perspective is needed since fighting STEM qua STEM, i.e., without the larger picture, is like playing whack-a-mole, the same tangle of logics will appear in another guise almost immediately. The battle over STEM has to take place simultaneously over and in the context of resistance to testing, to privatization of schools, de-unionization, the role of money (and billionaires) in the control over government, and a variety of struggles over the hyper-valuation of entrepreneurship and innovation (as compared to sustenance, maintenance, community stability—this is a struggle with deep labor and gender implications as the work of maintenance has often been done by women and racialized labor (Bliss, 2016)). Luckily for my argument those struggles are ongoing, though the articulation with STEM or even neoliberal school reform broadly (of which STEM is just one manifestation) has been largely missing.

To understand the stakes in keeping in mind the larger picture, it is useful and important to remember that the endgame for any set of standards is student and teacher evaluation. Ultimately, the NGSS will be used to triage the student body into STEM wunderkind, STEM sufficient (ready for technoproletariat status), and the STEM disposable (and teachers will face this same fate, ultimately) through testing. In this
sense the struggle against STEM is just one part of the current “Opt-out” movement in the U.S. in which parents refuse to have their children evaluated and consigned based on corporate testing practices.

My point here, is that it is too facile to propose a counter-STEM curriculum without understanding that for most teachers in most schools, there is no way to implement such curricula without endangering themselves or, worse, making them carry the blame for not resisting the entire massive and weed-like structure of neoliberalism. It is a misrecognition of the moment of struggle in which we find ourselves to push such curriculum without also being willing to take on state (or provincial) representatives, governors, superintendents, etc. (excuse the U.S. centric framing of this). We are in a different zeitgeist than one of post-neoliberal implementation. I will suggest elements of what such a post-neoliberal science education might look like in the next section, but first I want to suggest a path from here to there. While this does not focus on STEM as some isolated and semi autonomous element, this struggle is necessary to transform science education into a pedagogy of justice, curiosity, and pleasure.

While neoliberalism as a dominant form of governance in the U.S. dates comfortably to the early 1980s, widespread resistance to its use in schools is less than 10 years. While pushback has been present since the publication of the A Nation At Risk report (Department of Health, 1983), teachers have not organized sustained resistance until the Global Financial Crisis (GFC) of 2008. If anything, the leadership of the two main unions in the U.S. embraced neoliberal education reform in the 1980s offering up slightly more teacher-friendly variants. This was necessary in part because neither party has taken strong stances against such reform. Both have been bold in supporting privatization efforts, standardization, and accounting (disciplinary) mechanisms.

This began to change in the conjunction of the Obama administrations use of competitions to coerce/seduce districts into compliance with accountability strategies and the GFC. One of the main authors (Diane Ravitch) of monumental legislation that introduced charters, alternative routes, and high stakes testing, known as No Child Left Behind (2001), flipped and started a national organization to fight exactly the sort of reforms she helped implement (see Ravitch, 2013). The internet, especially Facebook, Twitter, and the so-called blogosphere, enabled a whole generation of teachers and union organizers to publish a stream of critiques against the reforms (cf. Edushyster (Berkshire, 2016), Jersey Jazzman (Weber, 2016), and Curmudgucation (Green, 2016)).

Finally, alternative teacher organizations emerged to resist the reforms. The most important of these has been the Badassed Teachers Association (aka BATS, see Singer, 2016) and United Opt Out (2016). These two are dedicated to fighting education reform broadly (in the first case) and standardized testing more narrowly, in the second. BATs organize through social media, but are also meet face to face, and have been known to show up at school board meetings to literally stand behind a teacher being disciplined for resisting reforms. These actions (both in person and online) are known as swarms. BATS move quickly to overwhelm the comment threads of discussions that do not acknowledge the importance of the work of teachers, advocate for reforms, or otherwise blame teachers for the wrongs of the world. Opt Out is a national movement dedicated to informing parents of their rights to not participate in testing. These organizations unite suburban unschooling advocates with urban parents who see testing as reducing their children to disposable populations (Agamben, 1998). Critically, the Opt out movement hits neoliberal reform at its most important point: the testing which is at once a major profit center for Pearson, Inc. and its ilk, as well as the means by which schools can discipline and triage populations. On the one hand, reducing everyone to a set of scores allows trivialized comparisons of students, teachers, schools, and school districts, which can then force a whole auxiliary set of services to be brought into play, as well as industry and higher education to evaluate who is valuable and who is not. These numbers can (and have been) published to force parents and schools into a rat race of normative competition, often without valid basis (on value-added measures see Pierce, 2013).
My argument is that this is the main front of struggle at the moment, i.e., the organized resistance to neoliberal management of the schools. Rather than produce idealized curricula that teachers will feel unable to implement because of the disciplinary mechanisms in play, teacher education needs to be focused at this moment on providing pathways to these new teacher social movements. Teacher education, including for those operating under the rubric of STEM, need to fight for the very conditions of the job, because the job as it stands is not a place of creativity, imagination, joy/pleasure, or justice (nor has it been in school’s modern history—so we are fighting for something new).

So critical alternatives to STEM can only co-emerge with the resistance and breaking of the systems that STEM is an extension of: neoliberalism. Granted, it is helpful to have scenarios of what could replace it, models which are also arguments against the neoliberal in terms of collective educational goals contra-the neoliberal order.

**SPECULATIVE FICTIONS OF A POST-NEOLIBERAL WORLD**

While many of us have turned to science fiction as a mode for working out better futures for some time (Gough, 1992; Weinstein & Makki, 2009), there is a renewed interest in future fabulation as a means of achieving social justice. Volumes such as *Octavia’s Brood* (Imarisha, Brown, Thomas, & Institute for Anarchist Studies) and *Afro-futurism* (Womack & Ebrary Academic Complete (Canada) Subscription Collection, 2013), have renewed an interest in fictions as ways of organizing anti-oppressive, utopian futures. So let me indulge. I want to suggest a very different materiality than currently exists in the U.S. regarding education, but at the heart of this vision is conjunction in which schools are rehabitated to be centers for the provision of all sorts of care, an extension of what we have now, but with health, ecology, and collectivity all being supported in the same building. “Class” i.e., periods of time could be tied to apprenticeships in which students leave the building or work in the building to maintain the health and well being of their communities in ways that require schools to work with local agencies, leadership, and social movements. This is an ultimately Deweyan vision in which “occupations” (Kliebard, 1986) become apprenticeship, in which formal curricula connect back to larger purposes.

In this vague utopian vision, two things are critical and contrast with the STEMification of education. First, there is a strong focus on place, geography in a broad abstract sense, as something, in Edward Soja’s (1996) language, “real and imagined,” becomes the matrix which shapes curricula. Some external standard, in the name of a hypothetical worker, is not what guides the selection and sequence that any given student moves through, it is a dialogic between local (including the global entering the local) and the desires of the student that drives learning. Second, there is a re-emergence of bodies here; bodies which in NGSS are almost entirely absent. There is no sense that learning of science starts with concerns over the body and the phenomenology of self. With a focus on health and ecology, maintenance/care rather than innovation, the body re-emerges as the text of curriculum in critical ways.

Finally, this is a deeply trans-disciplinary vision of education, of course, to think of health, is to think about culture, food, air, social organization, communication, etc. But these aren’t subjects; they are tools to help us grapple with the world as we have come to know us (and of course have helped shape the knowing of that world—in Hacking’s words, we intervene to represent and represent to intervene (1983)).

Finally, amidst the push to engage the world this speculative fiction also needs spaces of deep play, of disengagement, of students pursuing passions, of students fantasizing and trying different, unimagined roads. While much of this vision has been about a school re-envisioned to be integrated and of service to communities, part of growing and learning is also to fantasize otherwise, to act out, to explore. Somehow this school-to-be must allow such ludic spaces as well as those of service.
So on what grounds can we argue for such a different school-world. Our (again, this is emergent out of conditions in the U.S.) miserable rankings on questions of health, infrastructure, ecology, inequality, and legacy and enduring oppressive systems cry out for this kind of vision—which is neither unique or original. What the vision does is take us out of a lie, that technical fixes in the form of accountability/audit systems, or STEM and innovation address these concerns. At best they defer it, producing one commodity or another to address the commodification we now wrestle with. Relocating the power and focus of pedagogy in ways that are at once more traditional (Lave & Wenger, 1991) and more individual in ways that respond collectively to the lived experience of communities seems a more sure way forward.

REHEARSAL

In this piece I have argued that we need to understand STEM as nothing but neoliberal governance in all its toxic failure in a particular packaging which seduces the sciences into participating in their own corruption. Against this I have suggested a specifically utopian vision of education as central part of community renewal and re-imagination. Between these two worlds stands something like a revolution. That liminal space is where we find ourselves, and it is there we, as science educators, need to rethink our work and connect with the great movements now working to make the world more just.

REFERENCES


