

Ethics are Not on the Test: Diffraction and Affect in Education Policy

Kathryn M. Bateman
Michigan State University
Batema34@msu.edu

Brandon Sherman
Indiana University, Perdue University at Indianapolis
shermanb@iu.edu

Sophia Jeong
The Ohio State University
jeong.387@osu.edu

Abstract

The ethical teaching of science education is a complex challenge encompassing the ethics of teaching, the ethics of science, and the ethics of teaching science. Baradian agential realism provides us with theoretical tools to highlight ethical implications of policy, specifically standardized testing and science standards, in a narrative derived from the experience of a science teacher. The relational ontology of intra-action in Barad's agential realism provides us with a way of seeing and navigating co-constitutive entanglements of political, economic, scientific, educational, human, and material forces, ultimately allowing us to reveal the possibility in science education—the what is and the what could be. We explore the narrative through the theoretical lenses of diffraction and affect, and the entanglement of these two approaches. Thinking through entanglement allows us to position science standards and classroom realities as diffracting rather than clashing. These more-than-human actors influence each other to produce emergent becomings rather than standard implementations. By employing affect, we can approach these entanglements to acknowledge the ways in which *affective turns* (that is, moves towards noticing the interplay of affect, emotion, and feeling) impact both the actors (human and non-human) as policy and science teaching intra-act in a becoming that produces new classroom practice.

Keywords: Science education, policy, science ethics, affect, agential realism, diffraction

Affect the Ethics of Testing: A Narrative

I packed the final box from the school year neatly in the corner of my classroom. Beakers, baking soda, and batteries waiting for another group of eager minds to join the practices of science in September. But before that, there was a battle to be fought – the Pennsylvania State System of Assessment, or PSSAs, the Pennsylvania Department of Education's response to the federal mandate of No Child Left Behind (NCLB) to assess students. I had volunteered to serve on the committee that meets yearly to vet and edit new questions. I felt strongly opposed to these tests. I knew what they measured (students' recall skills) and

what they did not (anything else about the students' skills or abilities). Teachers from across the state would be meeting with representatives of the Department of Education and the testing company for two days at a conference center near the capitol. We were to look for errors, unclear points, and biases against certain groups of students.

I wish I could recall exactly what was said, but I remember clearly what I felt. The anger, frustration, and despair are fresh in my memory. I was the only teacher in the room representing students from an urban center. The other 11 teachers were from suburban and rural districts. Pennsylvania has almost 1.7 million students and over half of them, more than one million, are white. Philadelphia serves approximately 11% of the students in the state, but 40% of Black students and 20% of the state's Latina/o students. Although the participating teachers were geographically diverse, I was the only one speaking for over 200,000 students in Philadelphia.

The narrative above was written by Katie, the first author, who, in the early 2010s, was a middle school science teacher and science curriculum coordinator in Philadelphia, Pennsylvania. She taught in a school with a population that was over 90% free and reduced lunch and over 90% Black and Latina/o students with a large emergent bilingual and special education population. At that time (and currently, as of this writing), Pennsylvania administered the state standardized test, the Pennsylvania State System of Assessment (PSSA) for science in 4th and 8th grade, with an end-of-course test in biology in high school.

What is Policy Anyway?

Educational policies such as those behind standardized testing are often positioned as forces in themselves, operating on schools and classrooms from above (Bateman, 2019). Teachers are tasked with implementing these policies with fidelity. Yet, educational policies do not exist in a vacuum. Their development and implementation are influenced by factors within and beyond the educational system (e.g., parents and communities, industries). Messages regarding policies move through an educational system in “dynamic associations,” or assemblages (Koyama & Varenne, 2012, p. 157). In these assemblages, teachers interpret, disassemble, and reassemble policy messages so that policies evolve and emerge (Koyama & Varenne, 2012). Therefore, policy translation is inevitable and necessary (McLaughlin, 1987; Spillane et al., 2002). It is worth exploring this process, as it is this translation, more than the content and intentions of policies and reforms themselves that is likely to shape the day-to-day experience of students in schools (Cuban, 1998). We argue that the theoretical framework of agential realism (Barad, 2007) provides a novel and productive way of understanding the complexity of educational policy and school-based enactment.

Here, we consider dynamics between policies and classrooms with a focus on science ethics in science education. We examine policies as producing science ethics in a particular way, and how these policies are *diffracted*, bent, distorted, in encounters with a science teacher and her affective embodiment of science ethics. We do this through the interweaving and discussion of a narrative, introduced above, in which a teacher, the first author, wrestles with the ethical implications of teaching to standardized tests that devalue her students' contextualized scientific knowledge. Throughout, we combine two concepts to think with theory (Jackson & Mazzei, 2018). We entangle and think with Barad's agential realism (2007) and Danvers (2016) affect theory to gain insight into the ways teachers, policies, political/economic forces, and science

ethics encounter each another. We also look at the dynamics of these encounters and their diffractions.

The Emergence of Testing Policies

The PSSAs did not appear overnight; they emerged through iterative cycles of policymaking starting in the 1960s in the US that positioned standardized testing of students as a valuable metrics of schools. However, policies have unintended outcomes, taking on lives of their own (Bateman, 2019). For example, in the US, existing standardized tests in science implicitly favor native English speakers from the dominant culture who have educational, family, and community science experiences (Penfield & Lee, 2010). However, many students have not had these experiences, particularly those in culturally and linguistically diverse communities. These policies have affected schools in numerous unintended ways, including decreased time in science (Au, 2007; Aydeniz & Southerland, 2012; Judson, 2013) and narrowing science curricula (Au, 2007) to focus on tested content (Aydeniz & Southerland, 2012), dating back to at least the 1990s internationally (Atkin & Black, 1997). However, due to international assessments like the Programme for International Student Assessment (PISA), the Trends in International Mathematics and Science Study (TIMSS), and the Progress in Reading Literacy Study (PIRLS), the impact of standardized testing is felt across the globe (i.e., Jeong et al., 2022; Ma, 2021; Suprapato et al., 2021).

Katie's familiarity with the adverse effects of these policies, at least partially, contributed to her reactions to the PSSAs. Subsequently, she pushed back. For her, these standards were wrong. They did not reflect her complex and embodied understanding of what her students needed to become scientifically literate, to become practitioners of science, and develop an ethical idea of what those things mean. Here, we focus on that last idea, scientific ethics in science education.

Competing Ethics: Science and Education

The place of ethics in science teaching is a layered and nuanced issue. First, one must consider ethical dilemmas in the practices and processes of science. Researchers are likely to be familiar with ethics committees that ensure research does not cause undue harm to human and non-human subjects, or, essentially, that studies are ethically sound. Moderation of research on human subjects resulted from researchers dehumanizing marginalized communities in the name of science. Examples include the intentional harm of Black Americans in medical studies (e.g., the Tuskegee Syphilis studies) and Nazi experimentation on predominantly Jewish prisoners during World War II (Weinstein, 2008).

Furthermore, ethical considerations of science concern the outcome of the work. One example is nuclear power, which can produce both catastrophic destruction and plentiful energy that could counter Anthropogenic climate change (Manchin, 2020). Although it appears early nuclear scientists like Fermi and Meitner were driven by curiosity, seeking to explain a puzzling phenomenon, governmental forces in this system that enabled their research used it to create atomic bombs. Science was weaponized to maintain power. The scientists' creativity, the urge for political power, and needs for energy-power intra-act in an ethical entanglement (Barad, 2017). Scientists contemporary to Fermi and Meitner went along with weaponization of this atomic discovery, as the ideologies and discourses of neoliberalism infiltrated scientific practice. These ideologies and discourses can be found in modern science education materials (Bazzul, 2016).

Ethical considerations of science teaching pertain not only to science but to teaching as well. An extensive review of the research on ethical teaching (Campbell, 2008) suggests that ethical or moral teaching entails the teacher acting as a moral role model, exemplifying a good person (or good scientist) for their students. For science educators, the moral model also needs to be inclusive of the social justice imperatives (Chowdhury et al., 2020; Szostkowski & Upadhyay, 2019). For example, action on climate and standards reform should be explicitly linked with classroom practice (Bateman et al., 2021; Jeong et al., 2021). When standards fail to explicate the ethical dimensions of climate change, or mention climate change at all, teachers face ethical dilemmas. Do they abide by their perceived obligations to teach the standards as written or do they engage with their scientifically constructed ideas about what is ethical? The ethical tensions emerging from the narrative we present here are a force, something driving one teacher to meet established policies and confront them. This could be read as a clashing. However, there are other ways to think about this encounter, not as a conflict but as a process of translation, or perhaps better yet, of diffraction.

Policy, Implementation, and Diffraction

Policy implementation is often understood as a top-down, hierarchical affair. Policy-makers identify problems plaguing a group over which they govern, targeting narrow policy windows during which policies can be pushed through (Kingdon, 2003). These policy windows are often created through the generation of a crisis (Tyack & Cuban, 1995) such as claiming that children were “falling behind” or a country was losing its economic power. Policymakers then use policy instruments or tools such as mandates and monetary compensation to generate compliance (McDonnell & Elmore, 1987). Yet, policy implementation is not a straight line, and school systems change the reforms designed to change them (Cuban, 1998; 2013). As policies become entangled with other parts of the system, teachers and other actors interact with the policy, they may be adopted, adapted, combined, or outright rejected in practice, being assimilated, and translated often into something that migrates far from the intention of policy-makers (Bateman, 2019; Coburn, 2005; Coburn & Woulfin, 2012; McLaughlin & Mitra, 2001). Through their actions, teachers exercise power in relation to policies with which they disagree, such as standardized testing (Bateman, 2019; Sherman et al., 2020).

This process of implementation might be thought of as the clash of opposing forces in hierarchies. Another way to think about it is production in constitutive encounter – not interaction but intra-action. To this way of thinking, policies are brought into a complex assemblage with a multiplicity of human and non-human elements, thereby becoming, and helping to produce, something different (Youdell, 2015). Karen Barad’s (2007) agential realism provides a way to think about the dynamics of policy implementation not as a collision of distinct and separate forces, but as a *diffraction* of relational and co-constitutive elements, not colliding but converging like overlapping waves to bend, distort, and produce something new. It is a way of understanding how different elements of the world come to matter. Taking this perspective, policy is not something implemented *in* schools but is made a part *of* schools in their dynamic specificity.

In describing her agential realist ontology through the example of scientific experimentation, Barad (2007) explains that there is no inherent separation between measuring agencies and measured objects, between observer and observed, or between experimenter and experiment. Put another way, there is no outside position from which to observe and measure something. Rather,

these divisions are boundaries that are drawn rather than discovered, “agential cuts” that allow us to think in terms of causation amidst entangled phenomena. Policy, too, can be understood in this light. Agential realism has been used as an analytical framework to understand policy implementation, allowing for consideration of affective forces at play, in assessment, in higher education (Thiel, 2020) and how universities themselves can be reconfigured by the socio-technical entanglements of policy (Brøgger & Madsen, 2021). This perspective can be applied to policy at multiple levels. First, policymakers themselves can be understood not as outside of policy and its effects, but entangled with them, separated by an agential cut that poses them as the makers and policy as made. Within Katie’s narrative, we see how she is part of this system, both being influenced by the test, and shaping the test through her actions. Second, the policy specifically dictating measurement of student achievement can be understood not as inherently separate from the measurement and the measured (students), but as entangled with each and made distinct through agential cuts. Finally, teachers ultimately implementing policy can be seen as entangled with it, as they interpret, select from, and adapt this policy. It is to this position, that of the individual teacher, that we again turn.

Tears and Teaching: The Affective Policy

I shed tears that weekend. I lost my temper when pushing back against the group regarding “integrated pest management.” This was a common-sense idea to students in farming communities, which make up much of the landmass at the center of the state. For my students though, farms were things out of storybooks and school trips to pick out pumpkins already harvested from the vine. They had rich life experiences, and I had taught the concept the year before to my sixth graders by equating it to how one gets rid of mice in your house—set traps, get a cat, use chemicals mice do not like. But the questions situated in a farm with beetles and crops were unfamiliar. If my students were expected to grasp it from a farming perspective, why couldn’t we flip the question and phrase it in an urban context? This was met with looks of incredulity. Why would they do that when the standard is about farming? One of the rural teachers then told me that there are plenty of things we, the urban communities, spend far more time doing than they do, like fire safety. This is when I lost my cool. See, fire safety, while incredibly important when living in attached housing, is not part of the state standards in any curriculum. “Show me where that is on the test!” I cried, probably too loudly. I had to leave the room. One of the leaders came out to ask if I was okay, but without any apology from anyone, without the question changing or anyone acknowledging the biases and privilege that was in place. I left that weekend feeling even more frustrated with educational policy and testing than I had going into it.

Policies are interpreted and implemented by human educators. Katie’s narrative illustrates an embodied element to this implementation: affect. Affect is a constitutive relationality between bodies and objects co-produced by individuals and their social contexts (Mulcahy, 2019). In this sense, relational bodily affect can be understood as changes in “bodily capacity which emerge through encounters” (Mulcahy, 2019, p. 94). In Katie’s narrative, affect set in motion relations between bodies, including her fellow teachers (human actors/bodies) and standards and policies (non-human actors/bodies). During the meeting, conversations became increasingly heated. Katie reacted physically, shouting and leaving the room in frustration, trying to resist inequities she saw in the testing practice. Affective intensities, encompassing or preceding emotion, are eruptions and flows that emerge in encounters between elements in

assemblage (Colman, 2010). Affective intensities can be produced and reproduced through agential realist socio-material-discursive entanglements (Danvers, 2016), as we see in Katie's narrative. Katie's affective intensities opened up moments of ethical potential where "new thinking, feeling, seeing and being with others" can be imagined or enacted in a new way (Means, 2010, p. 1090). Since the posthuman conceptualization of agency no longer privileges human actors, all things/matter/bodies have a capacity to affect and be affected and these changes in bodily capacity can both affect other actors/bodies and are affected by them (Mulcahy, 2019). In this vein, the policy and standards, which have been typically perceived as dehumanizing forces, can be re-imagined as bodies with the capacity to affect others, especially Katie.

As a counter to education and policy as structured and rational, affect allows us to consider forces in schools not rational, not structured, but very real (Kenway & Youdell, 2011; Nairn & Higgins, 2011). In fact, educational policy itself, specifically, accountability-related policy, has affective affordances (Lingard & Sellar, 2013). Teacher emotions, related to their enactments of self (professional or personal) are entangled in their decision-making, acceptance, and resistance (Benesch, 2018; Zembylas, 2003). Thus, Katie's science teacher *becoming* cannot be separated from affect which demands a non-rational, not irrational, response and elicits a sense of response-ability. Here, Barad's (2007) idea of response-ability is germane, as "an ability to respond, to respond to the world beyond oneself, as well as a willingness to recognize its existence" (Kuokkanen, 2007, p. 39). Katie's affective *becoming* was illustrative of entities that do not pre-exist but co-constitute each other. Through and in their ethico-onto-epistemological entanglement we see that ethics, becoming, affect, knowing are inseparable (Barad, 2007). Once viewed as dehumanizing and oft neutral and objective, Katie's affective becoming made policy and standards messy, exposing inequities in the way policy and testing practices were implemented. These encounters, where Katie's affect clashed with the bodies of the others (her colleagues as well as the policy and standards), provided space to challenge the biased assumptions and consider ways to enact science teaching more justly and ethically for Katie's students.

As such, relationality and response-ability necessitate that ethics of science teaching be at the forefront of (in)equities and social justices concerning science education. Mulcahy emphasized, "learning to affect and be affected by human and non-human" actors is essential to a [teacher's] becoming "and, at the same time, her being in the world" (Mulcahy, 2019, p. 104). Affect mattered in Katie's teacher becoming to be more response-able; that is, opening a state of responsiveness and openness towards relationships towards both human and non-human others. Ultimately, affect entangled in the socio-material-discursive encounters and made new possibilities for response-ability and ethical becoming of a science teacher, Katie, who was passionate and committed to "thinking-feeling-doing" posthumanist ethics to consider often unimagined and alternatives ways of how policy and standards can be implemented in a more response-able way.

An (In)conclusion

As summer progressed, I spent a week with science education researchers in professional development around earth science and the developing Framework for K-12 Science Education policy document, philosophically counter to my time with the state. Our goal was to teach scientific practices, position students as knowledge producers, value their questions – not get them to a correct multiple-choice answer. When I returned to my school in the fall, I was asked to move from sixth to eighth grade. Why? Because eighth grade is the year science is part of the PSSAs and they wanted the students to do well. My salary for the following year would be tied to their performance on that test. My observations would be tied to how well I was covering standards, not how well my students could make observations, ask questions, or craft arguments. Our first unit of the year was on astronomy. We started big, with the big bang. My students had more questions than I had answers, but we didn't have time to ponder, to wonder, to think about the possibilities. We had more science to "cover." We had to talk about fossil fuels and all the good they bring to Pennsylvania and its economy in the same year we discussed the issues around global warming and rising sea levels. We needed to review integrated pest management, absent conversations around GMOs and pesticides. In the last weeks of March, I was reminded to "get them ready for the test." As a rule follower, I reviewed all the content from 5th through 8th grade in the standards that might show up on their test. Our do-now for the entire year had been a series of questions pulled from practice test questions, an ethical compromise allowing me to spend as little time on "test prep" as possible to save time for modeling, questioning, designing.

All things that influence a policy's creation and implementation, they are inseparable from one another. The (biotic, material, scientific, etc.) intra-actions had by all human and non-human actors that are part of this assemblage influence, shape, and change it in all moments. However, agential cuts (Barad, 2007) must be made to represent this system. We chose to represent diffraction and affect within the assemblage through the lens of a single teacher grappling with the ethics of teaching science.

Though hierarchical and uni-directional binaries have often been cast between the policymakers at the top and the people whom the policy influences at the bottom, we want to pose a different viewpoint from geosciences. Mantle convection is often showcased in middle school science classrooms through a water-based model. Heat is applied to the bottom center of a glass tray, ice to the top sides. Food coloring dropped in begins to slowly make visible the slow-moving, tumultuous path of the water as the two colors begin to swirl, creep, and reach out towards one another. At first, the two colors/temperatures appear different and distinct, but as time passes, wisps of red and blue begin to curl around one another, sometimes intermingling, sometimes *becoming* shades of purple. The convection process continues to swirl together, repeatedly heating and cooling the fluid, moving it through the system. In the same way, policies move between different spaces within the education system – policymakers, schools, classrooms, communities – and *become*. They create something new with each intra-action, picking up ideas, resources, funding, people, values, beliefs, and, like the water, remain invisible to the casual observer. Applying non-linear theory and examining these assemblages with attention to the influence of ethics and affect allows us to color the water and trace some of these paths. Understanding of how we might disrupt the flow to shape policy-becoming in more ethical ways

can emerge more clearly when we utilize the “food coloring,” that is, we make apparent and reveal the tracings of each of these theories.

We have endeavored to showcase how posthuman theories can help us re-imagine the role of policymaking and becoming in science education. At a personal level, the vignettes illustrate Katie’s *becoming* through her encounters with policy and affect, and their entanglement with the ethics of teaching science. Out of necessity, our representation of this assemblage must be incomplete, highlighting just one actor, just one element. We can neither know nor represent the impact of Katie’s affective turn on the other members of the meeting that day, or the ways that a multiplicity of other elements may have been operating. There is a sense in which employing this way of understanding the world means making peace with incompleteness, at least in terms of representation. We can never capture it all, nor should we try to. More questions can always be posed. What could other teachers *become* in response to the intra-actions presented here, and how did it influence their approach to ethics and science teaching? What do readers of this piece become in response to these vignettes? What affect arises in these reader-text intra-actions? What other elements might have been at play, and what might they have produced in intra-action? We hope these applications of posthuman theory to science education policy analysis set the stage for more such exploration, growing organic and affirmative understandings of what is produced in diffractive encounters between policy, teachers, learners, and educational spaces.

References

- Atkin, J. M., & Black, P. (1997). Policy perils of international comparisons: The TIMSS case. *Phi Delta Kappan*, 79(1), 22.
- Au, W. (2007). High-stakes testing and curricular control: A qualitative metasynthesis. *Educational Researcher*, 36(5), 258-267. <https://doi.org/10.3102%2F0013189X07306523>
- Aydeniz, M., & Southerland, S. A. (2012). A national survey of middle and high school science teachers' Responses to Standardized Testing: Is Science Being Devalued in Schools? *Journal of Science Teacher Education*, 23(3), 233-257. <https://doi.org/10.1007/s10972-012-9266-3>
- Barad, K. (2007). *Meeting the universe halfway: Quantum physics and the entanglement of matter and meaning*. Duke University Press.
- Barad, K. (2017). No small matter: Mushroom clouds, ecologies of nothingness, and strange topologies of spacetime-mattering. In A. Tsing, H. Swanson, E. Gan & N. Bubandt (Eds.), *Arts of Living on a Damaged Planet: Ghosts and Monsters of the Anthropocene* (pp. 103-120). University of Minnesota Press. <http://www.jstor.org/stable/10.5749/j.ctt1qft070.10>
- Bateman, K. M. (2019). *Assembling policy dilemmas: Science teacher responses to educational policy* [Unpublished Doctoral Dissertation]. The Pennsylvania State University.
- Bateman, K. M., Steele, D., & Sexton, C. M. (2021). Sustainability science education: Our animalistic response-ability. *Cultural Studies of Science Education*, 16(3), 841-855.
- Bazzul, J. (2016). *Ethics and science education: How subjectivity matters*. Springer International Publishing.
- Benesch, S. (2018). Emotions as agency: Feeling rules, emotion labor, and English language teachers' decision-making. *System*, 79, 60-69. <https://doi.org/10.1016/j.system.2018.03.015>
- Brøgger, K., & Madsen, M. (2021). An affirmative-diffractive re-reading of the policy instrumentation approach through agential realism and the accreditation instrument. *Journal of Education Policy*, 0(0), 1-19. <https://doi.org/10.1080/02680939.2021.1938239>
- Campbell, E. (2008). The ethics of teaching as a moral profession. *Curriculum Inquiry*, 38(4), 357-385. <https://doi.org/10.1111/j.1467-873X.2008.00414.x>
- Chowdhury, T., Holbrook, J., & Rannikmäe, M. (2020). Socioscientific issues within science education and their role in promoting the desired citizenry. *Science Education International*, 31(2), 203-208. <https://doi.org/10.33828/sei.v31.i2.10>
- Coburn, C. E. (2005). Shaping teacher sensemaking: School leaders and the enactment of reading policy. *Educational Policy*, 19(3), 476-509. <https://doi.org/10.1177%2F0895904805276143>

- Coburn, C. E., & Woulfin, S. L. (2012). Reading coaches and the relationship between policy and practice. *Reading Research Quarterly*, 47(1), 5-30. <https://doi.org/10.1002/RRQ.008>
- Colman, F. (2010). Affect. In A. Parr (Ed.), *Deleuze dictionary* (Rev. ed., pp. 11-14). Edinburgh University.
- Cuban, L. (1998). How schools change reforms: Redefining reform success and failure. *Teachers College Record*, 99(3), 453-477.
- Cuban, L. (2013). *Inside the black box of classroom practice: Change without reform in American education*. Harvard Education Press.
- Danvers, E. C. (2016). Criticality's affective entanglements: Rethinking emotion and critical thinking in higher education. *Gender and Education*, 28(2), 282-297. <https://doi.org/10.1080/09540253.2015.1115469>
- Jackson, A. Y., & Mazzei, L. A. (2018). Thinking with theory: A new analytic for qualitative inquiry. In N. K. Denzin & Y. S. Lincoln (Eds.), *Sage Handbook of Qualitative Research* (pp. 717-737). Sage.
- Jeong, S., Bateman, K., Aslan-Tutak, F., Akaygun, S., & Safak, R. (2022). Entanglement of the United States and Turkish science and mathematics educators' becomings in different educational contexts: Conceptualizing STEM education using a Bakhtinian dialogic approach. In S. M. Al-Balushi, L. Martin-Hansen & Y. Song (Eds.), *Reforming Science Teacher Education Programs in the STEM Era: International practices*. Palgrave Macmillan.
- Jeong, S., Sherman, B., & Tippins, D. (2021). The Anthropocene as we know it: Posthumanism, science education and scientific literacy as a path to sustainability. *Cultural Studies of Science Education*. Advance online publication. <https://doi.org/10.1007/s11422-021-10029-9>
- Judson, E. (2013). The relationship between time allocated for science in elementary schools and state accountability policies. *Science Education*, 97, 621-636. <http://doi.org/10.1002/sce.21058>
- Kenway, J., & Youdell, D. (2011). The emotional geographies of education: Beginning a conversation. *Emotion, Space and Society*, 4(3), 131-136. <https://doi.org/10.1016/j.emospa.2011.07.001>
- Kingdon, J. W. (2003) *Agendas, alternatives, and public policies* (2nd ed.). Addison-Wesley Longman.
- Kuokkanen, R. (2007). *Reshaping the university: Responsibility, Indigenous epistemes, and the logic of the gift*. Vancouver, BC: UBC Press.
- Koyama, J. P., & Varenne, H. (2012). Assembling and disassembling: Policy as productive play. *Educational Researcher*, 41, 157-162. <https://doi.org/10.3102/0013189X12442799>

- Lingard, B., & Sellar, S. (2013). 'Catalyst data': Perverse systemic effects of audit and accountability in Australian schooling. *Journal of Education Policy*, 28(5), 634-656. <https://doi.org/10.1080/02680939.2012.758815>
- Ma, Y. (2021). Reconceptualizing STEM education in China as Praxis: A curriculum turn. *Sustainability*, 13(9), 4961.
- Machin, A. (2020). The agony of nuclear: Sustaining democratic disagreement in the Anthropocene. *Sustainability: Science, Practice and Policy*, 16(1), 286-297. <https://doi.org/10.1080/15487733.2020.1829847>
- McDonnell, L. M., & Elmore, R. F. (1987). Getting the job done: Alternative policy instruments. *Educational Evaluation and Policy Analysis*, 9(2), 133-152. <https://doi.org/10.3102%2F01623737009002133>
- McLaughlin, M. W. (1987). Learning from experience: Lessons from policy implementation. *Educational Evaluation and Policy Analysis*, 9(2), 171-178. <https://doi.org/10.3102%2F01623737009002171>
- McLaughlin, M. W., & Mitra, D. (2001). Theory-based change and change-based theory: Going deeper, going broader. *Journal of Educational Change*, 2(4), 301-323. <https://doi.org/10.1023/A:1014616908334>
- Means, A. (2011). Aesthetics, Affect, and Educational Politics, *Educational Philosophy and Theory*, 43(10), 1088-1102. <https://doi.org/10.1111/j.1469-5812.2009.00615.x>
- Mulcahy, D. (2019). Pedagogic affect and its politics: Learning to affect and be affected in education, *Discourse: Studies in the Cultural Politics of Education*, 40(1), 93-108. <https://doi.org/10.1080/01596306.2018.1549706>
- Nairn, K., & Higgins, J. (2011). The emotional geographies of neoliberal school reforms: Spaces of refuge and containment. *Emotion, Space and Society*, 4(3), 180-186. <https://doi.org/10.1016/j.emospa.2010.10.001>
- No Child Left Behind Act of 2001, Public Law No. 107-110.
- Penfield, R. D., & Lee, O. (2010). Test-based accountability: Potential benefits and pitfalls of science assessment with student diversity. *Journal of Research in Science Teaching*, 47(1), 6-24. <https://doi.org/10.1002/tea.20307>
- Sherman, B., Haneda, M., & Teemant, A. (2020). A rhizomatic case analysis of instructional coaching as becoming. In K. Toohey, S. Smythe, D. Dagenais & M. Forte (Eds.), *Transforming language and literacy education: New Materialism, Posthumanism, and Ontoethics* (pp. 104-119). Routledge. <https://doi.org/10.4324/9780429491702-6>
- Spillane, J. P., Reiser, B. J., & Reimer, T. (2002). Policy implementation and cognition: Reframing and refocusing implementation research. *Review of Educational Research*, 72(3), 387-431. <https://doi.org/10.3102/00346543072003387>

- Suprpto, N., Prahani, B. K., & Cheng, T. H. (2021). Indonesian Curriculum Reform in Policy and Local Wisdom: Perspectives from Science Education. *Jurnal Pendidikan IPA Indonesia*, 10(1), 69-80.
- Szostkowski, A., & Upadhyay, B. (2019). Looking forward by looking back: Equity in science education as socially just and morally healing action. *Cultural Studies of Science Education*, 14(2), 335-353. <https://doi.org/10.1007/s11422-019-09916-z>
- Thiel, J. (2020). Student feedback apparatuses in higher education: An agential realist analysis. *Discourse: Studies in the Cultural Politics of Education*, 41(3), 471-483. <https://doi.org/10.1080/01596306.2018.1494544>
- Tyack, D. B., & Cuban, L. (1995). *Tinkering Toward Utopia*. Harvard University Press.
- Weinstein, M. (2008). Captain America, Tuskegee, Belmont, and righteous guinea pigs: Considering scientific ethics through official and subaltern perspectives. *Science & Education*, 17(8), 961-975.
- Youdell, D. (2015). Assemblage theory and education policy sociology. In *Education Policy and Contemporary Theory* (pp. 110-121). Routledge.
- Zembylas, M. (2003). Emotions and teacher identity: A poststructural perspective. *Teachers and Teaching*, 9(3), 213-238. <https://doi.org/10.1080/13540600309378>