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# Provocations from the 'STS as a Critical Pedagogy' Workshop

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## Abstract

This research article is a collaborative set of reflections and provocations stemming from the National Science Foundation (NSF) funded workshop on *STS as a Critical Pedagogy*, hosted online during the summer of 2021 by Shannon N. Conley and Emily York at James Madison University. The workshop occurred over four separate sessions, bringing together forty participants (including six undergraduate students who contributed as both facilitators and research assistants). Participants self-organized into panels, leading the workshop collective to engage a host of questions, challenges, methods, and practices related to STS and critical pedagogy. Questions included the following. *What* characterizes critical STS pedagogies? *How* are critical STS pedagogies enabled and constrained by our institutional and disciplinary locations? *What* makes STS pedagogies travel? *How* might we imagine STS pedagogies otherwise? *How* do our pedagogies shape our

research and engagement in the world? *How* might we critically interrogate the boundaries between research, teaching, service, and engagement, and what becomes visible when we do so?

## Keywords

STS pedagogy; critical pedagogy; collaborative formations; interdisciplinarity; critical participation

## Introduction

### Emily York and Shannon N. Conley

In the summer of 2021, we (Shannon Conley and Emily York) hosted a National Science Foundation (NSF) funded virtual workshop entitled "STS as a Critical Pedagogy" (Conley and York [2021] 2024). Bringing together STS scholar-teachers primarily based in the US but also including some international participants and scholars working in transnational collaborations, the workshop foregrounded pedagogy as a legitimate area of STS inquiry.[1] The purpose of this workshop was to support the development of a strong community of STS scholars focused on pedagogy, and to elevate pedagogical interventions as key sites for STS inquiry, scholarship, and engagement. Participants shared tools, methods, approaches, questions and theories related to their understandings and practices of critical STS pedagogies. Imagined as a collaborative formation more than an event, the workshop was organized in conversation with participants, and comprised separate sessions over two months that were developed by participants around shared themes (STS as a Critical Pedagogy Workshop Participants 2021a).

This collaborative manuscript aims to engage the broader STS community in interrogating *what* STS might distinctively contribute to practices of teaching and learning, and *how* STS practitioners might take up critical and social justice pedagogies. Here, each panel provides a reflection and overview of key themes and questions that emerged in their panel. Rather than defining 'critical STS pedagogies' from the outset, we hope this article in *ESTS* can be read as a kind of provocation. We invite readers to elaborate, revise, and re-imagine STS as/and critical pedagogy, recognizing that what follows is partial, both enabled and constrained by our disciplinary, institutional, and geographic locations and the situated context of the workshop.

That said, our explicit engagement with critical pedagogy literatures and interest in foregrounding inclusion and social justice in STS pedagogies informed our NSF proposal for the workshop. In *Pedagogy of the Oppressed* ([1970] 2000), Paulo Freire framed pedagogy as inherently connected to arrangements of power, politics, and knowledge production. *Critical pedagogies* forge alternatives to a transmission-of-knowledge model and attend to power dynamics. Freire's mentee and colleague, Ira Shor, described critical pedagogy as including:

[1] The workshop was originally intended to be hosted in person, with the limited funds aimed at supporting participants for travel and accommodation to the workshop. This made it challenging to accept many participants outside of the United States. We prioritized scholars actively teaching in formal or informal spaces, explicitly engaged in STS and critical pedagogies.

> Habits of thought, reading, writing, and speaking which go beneath surface meaning, first impressions, dominant myths, official pronouncements, traditional clichés, received wisdom, and mere opinions, to understand the deep meaning, root causes, social context, ideology, and personal consequences of any action, event, object, process, organization, experience, text, subject matter, policy, mass media, or discourse (2012, 129).

Feminist scholar, activist, and educator, bell hooks elaborated further in *Teaching to Transgress*, where her own experiences in desegregated schools led her to identify a difference in "education as the practice of freedom and education that merely strives to reinforce domination" (hooks 1994, 4). These perspectives resonate with STS practices that center critique, question arrangements of power and authority, and encourage actors to conscientiously reflect on their own assumptions and biases while questioning, unpacking, and deconstructing practices of knowledge production—including STS practices of knowledge production.

Our own starting point blended insights from our experiences teaching STS to undergraduate applied science students in a public university in Virginia; our readings in critical, engaged, feminist, and socially just pedagogies (for example, Freire [1970] 2000; hooks 1994, 2010; Luke and Gore 1992; Crabtree, and Sapp, and Licona 2009); STS-informed writing in engineering education and ethics (for example, Cech 2014; Beddoes 2012; Boudreau 2015; Downey 2015; Lehr 2015; Joyce et al. 2018; Riley 2003; and Riley et al. 2009); and a growing body of pedagogy-oriented scholarship in STS and especially feminist science studies (for example, Barad 2000; Reardon et al. 2015; Giordano 2017; Bozalek et al. 2018; Nieusma and Malazita 2016; Kenny et al. 2019; Khandekar et al. 2020; Lasker and Simcox 2020; and Tomblin and Mogul 2020). We came to recognize that we had implicitly accepted the idea that while teaching was important to us, it was second to and separate from research, and separate from our other scholarly activities. We no longer wished to accept this.

While advances have been made within STS regarding centering pedagogy as a space of inquiry, at the time the workshop proposal was written (2019), we didn't feel there was sufficient attention to pedagogical scholarship within STS. We recognized and loved the pedagogical scholarship we saw particularly in STS and STS-adjacent spaces that were focusing on feminism, anti-racism, and social justice, but saw relatively few panels focusing on pedagogy at the annual meetings of the Society for the Social Studies of Science (4S), and limited publication on this topic in STS journals. We wondered if this gap might arise from one or more implicit assumptions at work within various STS formations: that sites of teaching and learning do not need critical interrogation as sites of knowledge production; that they are generally not valuable sites for research, experimentation, and intervention; and/or that STS pedagogy and STS research are necessarily separate practices in which teaching is merely a way to diffuse that which is understood through research.

The assumption that teaching follows research was roundly challenged in presidential remarks at the 2019 4S meeting by then-president Kim Fortun, an interdisciplinary scholar whose research and teaching focus on environmental injustice and governance. Conceptualizing teaching as merely dissemination of research implies a model of teaching-as-transmission, or a "banking model" of education (Freire [1970] 2000). To clarify, we do not mean that STS teachers are necessarily transmitting or banking

in terms of their pedagogical practices. Rather we argue that viewing teaching as a secondary practice to research might imply that STS knowledge (produced in the research domain) merely needs to be shared, or transmitted, in the pedagogical space in a unidirectional sense. We challenge the demarcation between research as producing knowledge and teaching as transmitting it, and seek to examine the spaces and practices of knowledge production and those of pedagogy where they mutually inform each other, intersect, and overlap.

To the extent that pedagogy has been considered less valuable, this likely stems from research institutions that are oriented more toward graduate training as well as systems for promotion and tenure that reward externally-funded research and publication. But also—and, not unrelatedly—teaching has historically been relegated as feminized, service-oriented work not requiring or contributing intellectual ingenuity (Park 1996). Yet the insights of STS as a field would seem to directly contradict an assumption that pedagogy is less valuable than research; or that sites of teaching and learning are not potentially important sites for STS research, experimentation, and intervention; or that STS pedagogy and research are intrinsically separate practices in which teaching merely diffuses knowledge created through research. For example, the ideas that knowledge production is messy (Pickering [1993] 1999) and situated (Haraway 1988) suggest that knowledge is produced in ways that are rarely linear and that are entangled in specific, embodied, and material configurations and power dynamics. Attending to these ideas can attune STSers to knowledge produced *by* and *with* our students, to the ways that teaching practices may inform our research questions and approaches, to the power dynamics that we participate in within our institutions and our classrooms, and to the ways that a critical openness to our students, relevant publics and lay experts, collaborators and interlocutors all contribute to STS knowledge production. Critiques of the deficit model (e.g., CLEAR 2021) might sensitize STS teachers away from the assumption that once they fill their students' deficit of STS knowledge, the students will embrace STS perspectives. Reflections on the role of cultural reproduction in the constitution and maintenance of disciplines (Lenoir 1997; Traweek 1988) as well as the coproduction of knower and that which is known (Barad 2007) highlight the ways in which teaching practices also contribute to the production of the STS educator and STS as a field; the knowledges and skills we understand as 'STS' are fluid and change over time.

Increasingly coming to see our work in the classroom as a form of critical pedagogy, we were also inspired by the critical participation framework that highlights reflexive interventions in which knowledge is co-produced and expressed as it travels across disciplinary and institutional spaces (Downey and Zuiderant-Jerak 2017, 2021; Lezaun et al. 2017; York 2018). We began to wonder: was our STS work outside the classroom—in our research and service—also a practice of critical pedagogy? For example, socio-technical integration research (STIR) in the lab can be seen as a mode of teaching and learning with scientists and engineers (Fisher and Schuurbiers 2013); engagement with policy- and decision-makers can create new spaces for mutual learning (e.g., John et al. 2019; Bernstein et al. 2017); and a number of citizen engagement projects can be seen as teaching and learning with both citizens and scientists (Chilvers and Kearnes 2016). Gary Downey and Teun Zuiderent-Jerak, STS scholars who have been integral to Making and Doing scholarship, outline a number of case studies that illustrate this movement of mutual teaching and learning in critical participation practices (2021).

Our own research and teaching were beginning to blend in provocative ways—for example, in our "Co-Imagining Futures" engagements in the STS Futures Lab undergraduate students co-facilitated workshops with faculty from various disciplines (mostly in STEM fields) to collaboratively reflect on questions of responsibility, ethics, anticipatory governance, and epistemic justice in the expert's domain (York and Conley 2019a; York and Conley 2019b). Turning our gaze to the classroom itself as a space of inquiry and knowledge production, we began to also examine our work outside the classroom in research and service through the lens of teaching and learning. This led, in part, to our more recent collaborative research project, *Collaborative Research and Engagement Architecture for Transformative Engagement with STS* (2021), in which we use critical STS pedagogies to cultivate new trading zones and collaborative partnerships between faculty in STEM and Humanities fields around shared questions related to science, technology, and justice.[2]

In the introduction to the Fourth Edition of *The Handbook of Science and Technology Studies*, the editors write, "Increasingly, STS also asks, how can our insights be put to work in ways that improve outcomes for people and the planet?" (Felt et al. 2017, 2). Focusing attention on STS practices of teaching and learning *in* and *outside* the classroom is one promising way to do this, especially with undergraduates who will likely go into disciplinary and professional fields other than STS. By framing the workshop in terms of *STS as critical pedagogy*, we hoped to not only interrogate how STS educators might do critical pedagogy in formal learning contexts but how a variety of STS practices might be understood as practices of critical pedagogy. We wanted to examine pedagogical sites as spaces where we might enact "experiments between what is and what might be" (Lezaun et al. 2017, 207) and as spaces of making and doing, where STS insights are not merely transmitted but formed, performed, and made exciting (hooks 1994; Nieusma and Malazita 2016). How might STS scholar-teachers be poised to "experiment with hybrid knowing spaces" (Law 2017, 48) in pedagogically sound and playfully innovative ways? And how might these practices further inform STS theories and methods?

In the next sections, each workshop panel reflects on key themes and questions that animated their session, and offers provocations for STS practitioners to think with concerning the rich possibilities of engaging with STS pedagogy. As workshop participant Ann Wu writes in reflecting on the workshop:

> . . .STS scholarship need[s] to approach pedagogy and pedagogical practices in situ as spaces and moments of knowledge production. . . . The many panel provocations shared in this article, from examining pedagogies in labs to rethinking rubrics for assignments, vividly demonstrate how this approach can be taken up.[3]

[2] This NSF project is a collaboration with Co-Principle Investigators: Elizabeth Reddy and Marie Stettler Kleine (Colorado School of Mines, 2021); David Tomblin and Nicole Mogul (University of Maryland College Park, 2021); Marisa Brandt and Megan Halpern (Michigan State University, 2021).
[3] Personal communication, August 23, 2023.

## STS Teaching and Thinking with Disabilities

**Crystal Lee, Cora Olson, Ashley Shew, and Courtney Forberg**

Within the university classroom, disability is often framed as an issue for legal compliance and not as a source of scholarly or pedagogical inquiry. However, centering disability as an important component of research and the classroom experience can open new scholarly possibilities. As Jillian Weise writes in "Common Cyborg," mythologies around medicine, technology, and human enhancement often attempt to erase disability, where the "engineer steers and manipulates the human to greater performance" (Weise 2020, 65). All technology, however, is fundamentally assistive: headphones augment your sensory experience and smartphones provide navigation assistance. By becoming attuned to the different technological narratives about human difference—where disability is erased completely or dangerously framed as something to be overcome—STS scholars and teachers can be better equipped to interrogate what Ashley Shew terms the "ableist tropes about what body-minds are good to have and what counts as worthy" (Shew 2020, 43). In other words, disability—like race, gender, and class—is a critical lens for analyzing the social life of technologies, and it helps teachers and students alike to re-imagine technological infrastructure, scientific understanding, and their relationships to the human body.

A disability-forward approach within the classroom (and not just in research) is especially important for inclusive STS pedagogy, as the academy can often be a lonely and hostile place for disabled students (Lee, Olson, and Shew 2021). Disabled students often face difficulties navigating university bureaucracy in order to procure documentation, and many more do not receive accommodations despite jumping through the right hoops. On top of this, many disabled students come to college believing that they have "overcome" their disabilities and do not seek accommodations. Disability-forward teaching acknowledges the difficulties students face and provides a nurturing environment for all students to do their best work. These practices can include, but are not limited to—flexible deadlines, clear (even over-specifying) rubrics that enumerate different models of "good performance," frank conversations about disability and university resources, or guidelines for late work that depend more on helping students complete the assignments as opposed to deciding whether or not an excuse was legitimate.

STS provides an exciting space for questioning set norms, and we think of disability positionality as uniquely situated to help shape classroom choices, assignments, and approaches to teaching that promotes disability inclusion. Overall, a disability studies-inflected approach to STS pedagogy is important in two major ways. First, it unsettles ableist technological and scientific ways of knowing within technoscience. Second, it unsettles ableist teaching practices within STS classrooms. This two-fold epistemological challenge works well for multilayered critical inquiry in STS teaching and learning. Given the breadth of students who take STS classes, disability-forward classrooms provide rich examples of how practice in other fields could be otherwise. We would challenge others in STS to value, learn from, and teach with disabled knowers, both in classroom content and in how they establish norms for their classrooms, assignments, and materials.

## We are Screwing Up and Sticking with It

**Monamie Haines, Elizabeth Reddy, sam smiley, and Lindsay Smith**

As educators, scholars, and students of STS with experience in different global contexts and commitments to feminist and decolonial work, the four educators on this panel (Haines, Reddy, smiley, and Smith) have organized our teaching and scholarship around decentering powerful binaries, such as:

- nonhuman/human
- men/women
- English/Spanish
- center/periphery
- democracy/autocracy
- reason/emotion
- sciences/traditional knowledges.

There's a lot of work to be done, and we are experimenting our way through it to encounter and consider the world in new ways (Tironi 2014; Parreñas 2018).

Many STS faculty may be unfamiliar with the literature of critical pedagogy—which is intimately connected with issues of social class and education after Freire and Boal (Freire [1970] 2000; Boal 2006)—or may struggle to seriously engage in topics related to class and power. STS is, after all, caught in at least two double binds. First, many people trained in STS rely on the high value placed on science and technology for financial and social capital. Second, STS case studies in scholarship often stop short of unpicking the snarl of politics that may not overtly be related to science and technology,[4] or that may be coercive and clientelistic and located in contexts where scientism is not considered culturally authoritative (Haines 2019; Ottinger, Barandiarán, and Kimura 2017). In the classroom, these double binds may translate into focusing too much on science and technology or shying away from the transformative pedagogical project of seeking to reshape and tear down the structuring forces of capital and power.

Embracing critical pedagogies also entails developing pedagogical interventions engaged with other traditions and practices. Our panel presented pedagogies that are engaged with the teaching and learning space: their politics (Haines 2021a), histories (Smith et al. 2019), and nonhuman relations (Reddy and Mancus 2021). We were reflective of our experiences (Haines 2020) and practices, including encouraging art and critical design among our students (Haines 2021b). We talked about the performative aspects of teaching (Boal 2002), and we shared our head and heartaches. We creatively coded one of our panel interventions into visual word play for reflective analysis (smiley 2021; Saldaña 2009). We learned that if the STS classroom is to be a place for critical pedagogy, we must embrace our hopes for our students: the opportunities to be personally, intellectually, and emotionally transformed by the kinds of insights we can guide them toward. And we must abandon the safe intellectual distance that STS scholarship can encourage. Instead, STS as critical pedagogy must be serious about messy investments.

[4] To see an example of STS analysis of low technologies of governance (sticks and stones), see: Haines and Sarkar 2020.

We are experimenting with knowledge and worlding in the classroom, and our interventions are forever incomplete and far from successful. We are invariably caught in institutional and political contexts that structure what we can accomplish within and beyond the classroom. The place and practice of a liberal arts education, for example, can be fraught around the world but also provide unexpected affordances. For example, Haines has taught STS in technical universities in Denmark and Singapore. In Denmark, she found the difficulties of using the terms "racism," "feminism," and "activism" in her institution, as the political discourse meant those words were not applicable for the near-perfect Danish society. In an engineering education context where ethics in technology development is implicitly presumed if one adheres to "Sustainable Development Goals," students were hesitant to critically reflect on their nation state, so often seen as a pinnacle of social democratic governance. Yet, the soft authoritarian context of a technical university in Singapore provided a space for a liberal democratic education and engagement. A foreigner like Haines was able to engage with activists and talk about politically sensitive issues, as they were done in the context of the seemingly apolitical domain of science and technology. While students were very eager to understand their positionality in Singapore, they were still operating within economic logics that valued certain test scores for future employment, such introspection sometimes gave way to test-taking modalities of approaching material. Both settings provide constraints and opportunities, but changing the conditions of possibility means challenging a coercive power structure that backs the possibility of employment as a foreign professor in Singapore, and provides convenience, security and identity of being Singaporean and Danish citizens.

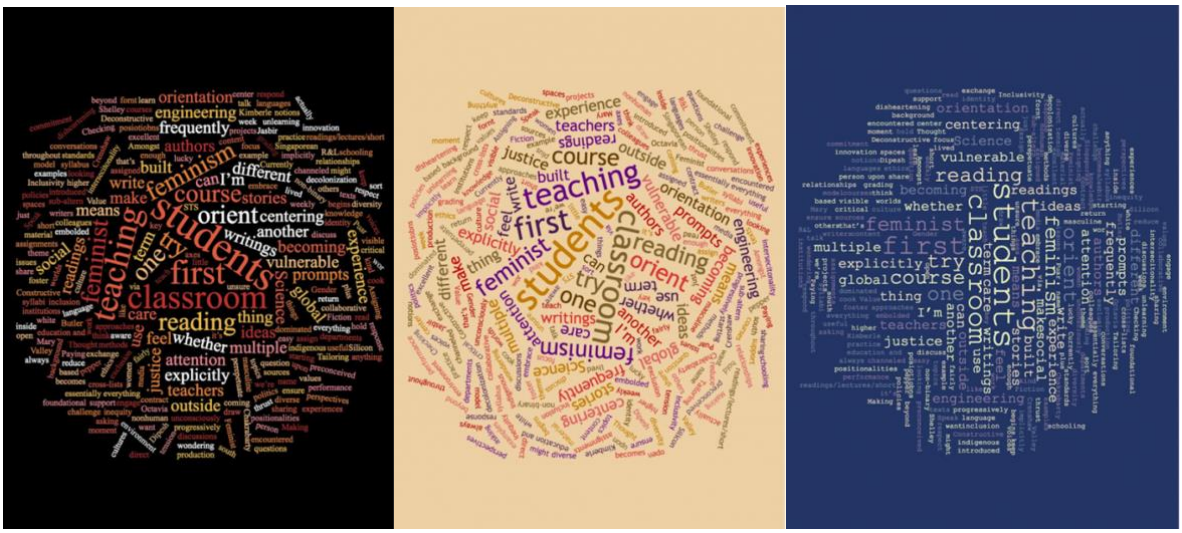
Reddy explored the implications of teaching STS at a polytechnic university in the United States, encountering a kind of positivist framework she had not seen elsewhere in her faculty career. This was evident as she developed and led a graduate-level course about risk and disaster for engineers and applied scientists. She experimented with strategies to guide students' attention to the ways that different knowledges and values could be related to different concerns, different calculative or affective relationships to their likelihood, and frame different kinds of rational actions. Even when she guided students through reading exercises and then led discussions of authors' "risk perspectives" in every class meeting, she found that many students remained puzzled. They still expected to leave the course with tools for estimating risk as an objective thing in the world. They did not see the texts she had carefully selected as providing contrasting viewpoints, but instead as building to . . . something. As she reconsidered the syllabus and developed new activities that might be more approachable, Reddy found herself both optimistic and pessimistic in outlook. She wanted to approach her class with hope and trust, and hoped her students would share that orientation. But did that mean presenting STS as a single mode of engagement with the world, a coherence rather than a set of provocations?

STS occupies a unique pedagogical space. Our "value" and place in many institutions has to do with our capacity to teach future scientists, engineers, and technologists. Our positions, and the expanding presence of STS more broadly, depend on certain knowledge hierarchies. Often these hierarchies, which celebrate singular, western-centric knowledge and value systems, help our students choose their majors and allow our departments to achieve their foothold in the modern university. However, through feminist, decolonial, and critical pedagogies, our courses often seek to destabilize those hierarchies and contest singular ways of knowing and western-centric views of progress and truth. Smith, teaching at a large US-

based state institution, developed a bilingual course taught in conjunction with scholars at a Latin American University. The course was designed to use language (e.g. reading in Spanish with the help of google translate) to destabilize students' learning comfort zones and consider other ways of thinking and doing science in the world. Students in the course described the transformative and generative experience of transcultural exchange; but often left feeling powerless about how to make these insights actionable in a world built to prioritize traditional forms of communication and knowledge production.

There are frictions, mismatches, and discomforts that cannot be domesticated in analysis. This is what it means to perform feminist, decolonial pedagogy while keeping in mind that we are all flawed, imperfect feminists and anti-racists, and might understand decoloniality differently. We know that our failures can result in harming our students and other interlocutors, and we endeavor mightily to not do so.

The images below (see figures 1–3) document collective thoughts of our workshop participants about teaching, using a waterfall technique that asked everyone to respond to a prompt within one minute, all posting their responses at the same time. We see reflected in these word clouds that participants all bring students together, considering their political and intellectual commitments. It is no coincidence that the word clouds all prominently feature the words "try" and "vulnerable" as well as more standard instruction language like "classroom," "reading" and "prompts" or topical, like "feminism" and "global." We offer three different versions of these words as a reminder that we do not expect those who share alignments and resonances with us to all experience them the same way. But what we seem to have in common is an ethic of experimentation, openness to failure, and a commitment to try again: in whatever ways, we all screw up and we all stick with it.




Left to right.

**Figure 1.** Prompt to participants in critical pedagogies workshop: how do you orient toward feminism/decolonial/more than human in the classroom? Word clouds represent the same data, triangulated three different ways. (smiley 2021).

**Figure 2.** Prompt to participants in critical pedagogies workshop: how do you orient toward feminism/decolonial/more than human in the classroom? Word clouds represent the same data, triangulated three different ways. (smiley 2021).

**Figure 3.** Prompt to participants in critical pedagogies workshop: how do you orient toward feminism/decolonial/more than human in the classroom? Word clouds represent the same data, triangulated three different ways. (smiley 2021).

## Making the Case for Ourselves: Boundary Objects in Critical STS Pedagogies

**Marisa Brandt, Sean Ferguson, Anna Geltzer, Kathleen Sheppard, and Kari Zacharias**

We mapped the intersections of our identities as researchers and instructors and the contexts we operated within (Clarke, Friese, and Washburn 2015), prompting reflection on being tasked with making a case for ourselves as scholars and instructors (Brandt et al. 2021a). Our narratives (ibid., 2021b) yielded a set of boundary objects (Star and Griesemer 1989) split among each author for personal exploration. The following distills our work choosing and negotiating our pedagogical boundary objects.

Brandt examined writing instruction (Brandt 2021). While often seen as a service-teaching burden, first-year writing instruction is an institutionally recognized requirement in undergraduate education that presents an opportunity for instructors to normalize critical approaches to technoscience early in STEM students' training by embedding STS questions and modes of inquiry into assignment design. Brandt illustrated how writing pedagogy can mediate relations across institutional actors through her own efforts to design an STS-grounded first-year writing curriculum for STEM students.

Ferguson drew attention to counting/qualifying work as self and labor is made (in)visible (Ferguson 2021), often to the detriment of faculty (Stromquist 2017), students (Slaton et al. 2019), and sustained critical pedagogical interventions. Presenting an experimental course that incorporated international engagement and service learning with reflections on "what is global engineering" (Downey and Beddoes 2011), Ferguson illustrated how the imperative toward quantified data and metrics impeded critical pedagogy and manifested as resistance to STS in engineering education. For example, non-tenured instructional faculty are paid to teach efficiently but are not paid to research and practice critical or transformative teaching methods.

Sheppard's boundary object was engagement (2021). The most important question is how to keep students engaged in the course material for history of science while at the same time asking them to investigate these disciplines with new questions, applying ethics, de-colonizing and de-misogynizing the narrative, and encouraging them to continue to think about these issues as they move forward with their careers.

Geltzer focused on creating institutional and curricular spaces for STS in her role supporting STEM education within complex boundary conditions (2021). Although inter/multi/transdisciplinary approaches to teaching are encouraged and emphasized by university administrations, implementing them in practice often proves challenging in academic settings where structural and epistemic barriers reinforce each other. How can we ensure that institutional spaces such as interdisciplinary centers constitute the nexus of interdisciplinary work rather than dead ends?

Zacharias discussed accreditation as a boundary object (2021). For STS faculty in engineering spaces, accreditation has been a means of articulating the legitimacy of their work. As a junior faculty member, Zacharias experienced accreditation requirements initially as a source of anxiety, and soon after as a central aspect of engineering education that nonetheless remained invisible to most students. Yet, by

using the "weakly structured" nature of accreditation requirements, she could invite students to discuss and critique the definition of engineering skills.

Altogether, our boundary objects demonstrate that STS is not only a significant asset as a field of study for engineering students and faculty, but it can also present tremendous barriers to reaching students.

## Making the Invisible Visible

**Eleanor S. Armstrong, Shelby Dietz, Sharlissa Moore, Ellan Spero, and Aubrey Wigner**

The inherently interdisciplinary and changeable nature of STS as a discipline means few people start as STS scholars, but instead move between various formulations and situated experiences of the STS field in different places/establishments and times. Our panel took a workshop-based approach to thinking about how to make different disciplinary backgrounds and knowledges brought to STS classes a feature of the class rather than a bug that needs to be ironed out (Armstrong et al. 2021). Arising from our panel we identified themes that helped students engage with their own situated knowledge. Making explicit the connections between technological systems and social impacts when working across different physical scales and the technological landscapes often hidden in the everyday (Spero and Ortiz 2021) or charting the social and geographic scales of infrastructures (Moore and Wigner 2021), introduces learners to thinking about the connectedness of technoscience artefacts. Assigning readings that subvert the learners' disciplinary backgrounds (Dietz 2021), and asking students to unpack what epistemologies are implicit in historical tools (Armstrong 2021) encourages students to step out of their situated knowledges and look in on them from a different perspective. All of our interventions encourage learners to think about what problems and questions are already understood to be certain within their own field by exploring it through another lens. Collectively we emphasize that one point of departure for critical pedagogy starts from naming the knowledge you bring to the already interdisciplinary field of STS, and how you *have* and *are* framing that knowledge. We encourage educators and learners alike to notice what you are noticing; notice what you are questioning; and notice what you are taking for granted as already "certain."

We turned our attention to the role of our own pedagogical practices in highlighting the in/visible within our own disparate institutional structures, departmental requirements, disciplinary and field norms, metrics for success, and funding opportunities. With aligned interests in the provocative and productive potential of STS practices, we noticed both opportunities for collaborations, as well as barriers to engagement and change. We observed the relationship between institutional or discipline/field legitimacy and what is perceived as possible or even legible as pedagogy. The dialogue provoked productive questions to carry forward across pedagogical contexts. What might undisciplining the interdisciplinary mean? How might a focus on creative practices from the "out-side" both enhance engagement and simultaneously highlight power relationships hidden in the framing of disciplinary "core" and "periphery?" How might we problematize the metrics, incentive structures and hierarchies within the higher education system while also seeking legitimacy and legibility within these systems?

## Laboratory Life Redux: STS Labs and Clinics

**Anita Chan, Rachel Douglas-Jones, Ranjit Singh, Malte Ziewitz**

Laboratory life in STS can be quite different from its counterparts in chemistry, biology, and physics. As spaces for learning, inquiry, and experimentation, STS labs and clinics are not yet widely used, tend to be precariously funded, and often fall between the cracks of their respective institutions. At the same time, it is these very features that allow them to do things differently: offering distinct ways of thinking about science, technology, and society, exploring alternative forms of community and creativity, and sometimes even fostering long-term institutional transformation.

In this panel, we reflected on these critical formations based on our own experiences in four laboratory settings (Chan et al. 2022) that each aim to intervene in technological solutionism: the Ethos Lab in Copenhagen, Denmark (Ethos Lab n.d.); the Community Data Clinic (2022) in Champaign, Illinois, US; the Data & Society research institute (Data & Society n.d.), a remote-first organization with predominantly US-based employees; and the Digital Due Process Clinic (Digital Due Process Clinic 2023) in Ithaca, New York, US. We organized our conversation around five themes that cut across our work. We first discussed the notion of space (Chan et al. 2021a) to ask: *what difference does a permanent or temporary space make for our pedagogies in STS, including educators, students, and external partners?* Second, we reflected on our relations with the institutions (Chan et al. 2021b) we are based in to ask: *what are the institutional affordances of doing STS pedagogy where you are?* This may be a disciplinary question, but it is also one that foregrounds situated techniques of intervention in communities of practice within and beyond the university. Third, we talked about politics (Chan et al. 2021c) to ask: *what are the ambitions, stakes, and consequences of our work for different communities of practice*? Fourth, we turned to materiality and specifically the objects (Chan et al. 2021d) that we use in organizing our work to ask: *how do specific artifacts shape and inform our pedagogies*? And finally, we considered students (Chan et al. 2021e) to ask: *what can student engagement look like in a laboratory, and how does it complement and challenge the more traditional roles of learners, teachers, and instructors?*

In all these areas, the discussion showed, STS labs, groups, and clinics can act as spaces for experimenting with novel forms of learning, scholarship, and engagement. Such spaces can also serve as connective terrains for drawing in and upon other—and even earlier—forms of experimentation in sociotechnical intervention beyond the classroom that imagined alternative forms of knowledge practice and production. For instance, a poetry rave on the occasion of a privacy law (Ethos Lab and Gahoonia 2018). a community-centered research collaboration to develop a local crisis response directory (Community Data Clinic 2022), a storytelling project on AI in/from the majority world (or the global south) that produces both stories and a syllabus (Amrute, Singh, and Guzmán 2022; Singh, Guzmán, and Davison 2022), and an initiative documenting the experiences of people struggling with automated scoring may not be immediately recognizable as coursework or assignments (Digital Due Process Clinic 2023). Yet the work they do—successfully or not—to challenge our collective sense of membership, community, and knowledge can be significant. Navigating these tensions among institutional demands, financial precarity, and service work is not an easy task—but promising as a pedagogy—not just for students but also for colleagues, institutional administrators, off-campus communities, and ourselves.

## Interrogating STS Pedagogies

**Martín Pérez Comisso, Eric B. Kennedy, James W. Malazita, Raquel Velho, and Matt Wisnioski**

Questioning is a central activity in research, but we often neglect to bring that reflectivity to our classrooms (Velho et al. 2021a). We discussed the notion of criticality in our pedagogical practices using artifacts from or around the classroom.

Four artifacts from the panelists articulated the tone of the conversation: Jim Malazita and Raquel Velho unfolded the assumptions and expectations in the curriculum for the *Design, Innovation and Society* major at Rensselaer Polytechnic Institute—the only design program in the US housed in a humanities and social sciences department (2021). They use a diffractive approach to interrogate design and STS around notions of representations, identity, and complexity. Matt Wisniowski introduced a simulation used in the STS program in Virginia Tech, taking the role of the reviewers of Social Text at the beginning of the Science Wars (2021). Eric Kennedy shared a series of artifacts used in teaching emergency management to think critically about uncertainty, forecasting/prediction, visual representations, and international comparisons (2021). Finally, Martín Pérez Comisso offered a learning activity from the University of Chile. Students produced and dissected video essays to reflect on notions of technology and STS, centered on object histories, science fiction literature, and movies (2021).

Thinking *from* and *about* these learning artifacts leveraged the critical capacity of the workshop participants to interrogate the very notion of critical pedagogy: What is it to reflect critically? Participants shared tensions, challenges, and interferences in the learning processes of themselves and their students (Velho et al. 2021b). To make a learning process critical for the students and their communities, Malazita described criticality as a way to "question to what degree things need to happen, not just why they happen and what needs to change."

To practice STS as critical pedagogy means to center attention on situated structures of power, engage multiple perspectives, perform an active and engaging pedagogical practice that values STS contributions, and self-reflect about our interventions. Critical pedagogy brings to the forefront the previous knowledge and identities of students to transform power relations, and as Comisso highlights with respect to STS specifically, involves empowering students with lenses to interrogate knowledge production and use. At the same time, Kennedy's case highlighted how both critical and pragmatic goals can co-exist, raising questions about STS's role in different learning settings. Velho highlighted her interactions with colleagues in the School of Engineering who emphasized in meetings with her the value of critical STS pedagogy for students across the school. In that sense, Velho emphasized that it is necessary for STS to pose its inherent value without "being a tool for others" to check off social responsibility from a checklist, whilst highlighting the important interrogations that an STS education can bring to students in diverse programs.

The panel concluded with an invitation to discuss other artifacts and produce a cookbook (Velho et al. 2021c) with diverse ways to do, perform, and practice STS in our educational contexts. The interrogation of the design, interaction, assessment, and interpretation of our teaching practices bring criticality to our crafts as educators.

## Cooking with STS: Lived Experiences as Ingredients

**Matthew Harsh, Nicole Mogul, David Tomblin, Damien Williams, and Hong-An Wu**

We came together as a group of STS scholar-practitioners who all use critical play to frame our approach to STS pedagogy—lenses that help us reflect and imagine what alternative ways of relating, being, and figuring may emerge in our pedagogies (Harsh et al. 2021). In an effort to playfully share our own pedagogies and allow workshop participants to critically play with us, we approached our session through the metaphor of cooking. In our workshop, we previewed some of our tried-and-true recipes, i.e. ways of teaching STS (Wu et al. 2021). These included STS approaches to grading, embracing STS systems thinking skills as superpowers (Tomblin and Mogul 2020), teaching STS through science fiction, and interrogating the co-production of gaming and technology. We then invited participants to imagine and share their own recipes (STS as a Critical Pedagogy Workshop Participants 2021b).

To transgress traditional modes of teaching, bell hooks (1994) reminds us that "we have to challenge and change the way everyone thinks about pedagogical process" (144). Pedagogical processes, when trafficked through the dominant language of schooling, lesson objectives and plans, degree and curriculum requirements, assessment and evaluation rubrics etc., often prefigure a kind of banking model of learning that Paulo Freire ([1970] 2000) critiqued and that neoliberal educational institutions commodified. In order to be mindful about naturalized conventions and invisible assumptions ingrained into pedagogical lingo, our panel subverts this common language with the layered significance of cooking to approach STS teaching, learning, and pedagogical processes. With debt to Ruth Cowan, *Kitchen Table: Women of Color Press*, and other scholarship enabled and practiced through gendered, classed, and racialized reproductive labor, we moved from sharing pedagogical recipes to a personally situated, facilitated recipe making session in which our participants played with ingredients—some they had on hand, some we asked them to incorporate directly—taking into account their own workspaces, fields, labs, neighborhoods, and towns as kitchens—to make a pedagogically nutritious and satisfying dish!

We reflected on how we might approach STS as critical pedagogy by placing play centrally in the pedagogical process, and we speculated on how cooking as a metaphor for teaching allows us to imagine system-level change. Playing *with* and *against* power relations and boundaries helps ask who gets to "cook," where, in what ways, and what resources they have at hand to do so. Based on the knowledge produced in this session, our panelists characterize critical STS pedagogies as not overly and overtly prescriptive. Like recipes, STS pedagogies are reflexive, interpretative openings and inscribed traces of what worked in particular places and times (Mogul 2021).

We conclude with a few provocations for you, the reader—

- How might you revise your pedagogical practice if you approach it from the metaphor of cooking?
- What constitutes a well-cooked meal and who decides?
- What tacit knowledge could you make explicit so that others may follow your recipes?
- How might you take our words here as recipes and try it out in your own research-teaching-service kitchens?
- How might you centrally feature the lived experiences of your students as co-cooks in the pedagogical dishes you make together?
- How might you invite your co-cooks to revise, reinvent, and remake your curriculums, lesson plans, and assignments as recipes?
- How might cooking catalyze institutional change?

## An Undergraduate Perspective

**Maxwell Etka, Courtney Forberg, Nolan Harrington, Alexa Houck, Danica Tran, and Andrew Webb**

We—the undergraduate fellows of the *STS as a Critical Pedagogy* workshop—are undergraduate students majoring in Integrated Science and Technology (ISAT) and minoring in various disciplines such as STS and sociology at James Madison University (JMU).[5] As part of the *JMU STS Futures Lab* (York and Conley 2019a), we investigate and critically interrogate socio-technical futures in a collaborative space with diverse scholars. During this workshop, we assisted in the preparation and execution of various *STS Pedagogy Workshop* panels through facilitation of panelist communication, conference scheduling, material organization, overall lab assistance, and introductions of the panels. We also attended all of the sessions and took notes.

One challenge of being an undergraduate fellow was finding our place within the workshop. Our duties were ambiguously defined, as they depended on what our panelists needed, and having such a relationship with faculty was novel to us. Initially we felt intimidated, and felt that we needed to prove ourselves. One of the most challenging events was introducing ourselves to workshop attendees with more life and educational experience, something that would be less challenging with peers. We were often aware of power asymmetries as we interacted with the tiny squares on the screen, as each of those boxes contained someone with larger experiences and knowledge of the STS field. In a sense, the typical student-professor role was reversed—we took on a significant leadership role in helping organize and administer the panels, an experience that was simultaneously empowering and challenging!

We also sometimes found that our experience as students in the classroom didn't align with professors' perspectives when engaging students on STS topics. In our experiences, in an applied STEM program where STS is integrated into the curricula, STS faculty are considered equal members of the department, and the *STS Futures Lab* is a physical reminder that STS is valued. Here, we perceive our peers in the STS classes as being inclined to think through an STS lens, and to want to be there and engage with the material. We recognize that our situation is unique and that this is not the case everywhere, as demonstrated in the panel discussions.

Based on our experiences as students and fellows for the workshop, we encourage professors to continue focusing on interdisciplinary instruction, as it can make spaces that generate more interesting learning. The conversational space that STS opens up between many different subjects can be a tremendous benefit for undergraduate students, as it provides a toolbox for students to communicate across different domains of expertise.

[5] All have graduated from James Madison University at the time of publication. Their current activities include careers in data science, engineering, project development, and product design, as well as graduate studies.

## Calling in a Critical Genealogy of STS Pedagogy

**Ali Kenner**

How, when, and where do we learn how to teach? This question gnaws at me from time to time, usually during course prep, at the end of the term, or when experiencing teaching challenges or successes. I wondered this, too, over the workshop month as I learned from other participants who shared their experiences, tools, and perspectives on teaching STS. I learned from Anita Chan, for example, what STS pedagogy looked like in the 1970s, and that there was a publication to support it.

My own critical thinking about learning as a transformative process (Kenner 2021)—a core tenet of critical pedagogy that I learned from reading bell hooks and Paulo Friere—began in 2002 when I took "Introduction to Women's Studies" at the University at Albany, SUNY. It's a course taught annually by a collective of undergraduate students, likely one of the last undergraduate teaching collectives in the US, a remnant of second wave feminism and the establishment of Women's Studies programs in the '70s. As a member of the undergraduate teaching collective a year later, I learned within a community of student-teachers-in-training how to expose and disrupt power relations, challenge learning norms, and usher creative practice into curriculum and classroom. Here—because critical pedagogy necessarily looks different across contexts—critical pedagogy was grounded in students' lived experiences, it was humanizing, it was process-oriented, and it was creative (Hamlin 2019).

Over time, as I entered one graduate program and then another, became a teaching assistant and accrued more and more time in the industry of higher education, critical pedagogy gradually disappeared from my courses. I can find only traces of critical pedagogy in the STS courses I teach today; a dramatic departure from the pedagogy I experienced and learned as an undergraduate student-teacher, where courses were designed *with* critical pedagogy rather than sprinkled *in*. A recurring theme that resonated for me over the month-long workshop was how our institutional situatedness and our institution's culture matter for curriculum and classrooms. Operating in an institutionalized setting where one is "junior" for sometimes more than a decade, I can't help but feel captured by a dominant culture that never served me as a student.

In the workshop "cascada" above, students are centered again and again. What would it look like to enter our pedagogy as teacher-students? Speaking for myself, I would resist the industry's white patriarchal capitalist temporalities by building in more time for rest, transition, and reflection. I would center sensory knowledge and the body-in-place through creative practice, movement, and sound. And I would de-center writing as the dominant form of learning performance.

I have been slowly making these interventions already. And I learned much from the many workshop participants who are already teaching these modes of STS praxis, weaving the rich tradition of critical pedagogy with our field's research, as well as science, art, and technology from other fields. Documenting this work, and situating it is imperative—and this project, *STS as Critical Pedagogy*, is a long-needed one. Genealogy is critical, too; an act of research and remembering that is needed for the experimental practices that anchor STS and the political transformation we hope to cultivate.

## Conclusion

**Emily York and Shannon N. Conley**

We envisioned this "engagement" in the *ESTS* journal as a way to share with the broader STS community the reflections and provocations that this workshop collectively generated, and to spark additional conversations about how STS might relate to critical pedagogy.

In reflecting on the workshop sessions and the contributions each panel developed for this manuscript, we recognize a number of shared themes, concerning the *what, how, who, where*, and ultimately, the *why* of STS as critical pedagogy. While these overlap, for the purposes of characterizing some of these themes, we might suggest that *what* and *how* highlighted the necessity of engaging with power in all of its forms, from interrogating capitalism to challenging the power dynamics within educational institutions and disciplinary formations, to reflecting on the power structures that might support STS scholars and teachers in ways that both enable and constrain critical work. Critical STS pedagogies, as discussed here, are experimental, reflexive, dynamic, interactive, and situated. With respect to *who* and *where*, there is a clear focus on engaging with students as whole persons with intersectional identities and valuable knowledges, and a keen awareness and explicit engagement with communities beyond the walls of specific institutions. There was also considerable reflection on how STS practitioners of critical pedagogy find themselves needing to justify their practice, their value, and sometimes their existence; and how they find themselves navigating barriers and negotiating tensions to do this important work. With respect to *why*, this is a mode of doing STS in the world that is all *in*—that is "serious about messy investments," (Bhadra Haines et al. 2024 "We Are Screwing Up and Sticking With It"). Scholars in this workshop spoke of feminist, decolonial, anti-racist, disability-forward work, of institutional transformation, and of the creative and political work of experimentation and worlding.

What does STS specifically contribute to critical pedagogy? The ideas collected here are themselves situated and partial, and some may be more obvious—like critical attention to science, technology, and knowledge production—and some perhaps less so. For example, STS may emphasize approaching interdisciplinarity as a skilled practice and way of enacting "situated knowledges" in teaching and learning (Armstrong et al. 2024). It may revel in methods of strategically leveraging infrastructural and institutional apparatuses and boundaries to facilitate critical pedagogy, as in the cases of instantiating STS within a first-year writing program (Brandt et al. 2024) or program assessment structure (Zacharias in ibid.), or creating STS laboratories and clinics (Chan et al. 2024). And it can entail mapping STS sensibilities to critical pedagogy in action: STS attention to material artifacts becomes artifact-based interrogations (Comisso et al. 2024) and STS attention to the iterative and social nature of knowledge production (and the work of metaphors!) becomes teaching (or cooking!) with our students, objects, communities, institutions, and each other (Harsh et al. 2024).

We especially note the reflexivity with which these STS teachers and scholars approach their teaching—always interrogating their own categories, definitions, practices, and contexts. This embodies disciplinary and epistemic humility, an attention to material practice, and responsiveness. By responsiveness, we mean the ways that participants demonstrated how their pedagogies responded to students, institutions, power dynamics, challenges. In fact, each pedagogical approach and experiment seemed to be creatively and carefully crafted in response to the specific, highly contingent set of actors,

institutions, historical moments, and material affordances at hand. This extended to our collective interest in creating space here for our undergraduate research fellows to contribute their perspective on the workshop (Etka et al. 2024).

At the same time, this specificity and particularity made visible shared goals for transformative and nourishing pedagogies that can challenge dominant structures of power, dominant paradigms of science and technology, and dominant practices of teaching. They made visible a recurring question that perhaps every workshop participant had wrestled with: *How* do we make STS matter? They revealed the sometimes joyful, sometimes painful ways that we have made STS matter through our pedagogies. Critical STS pedagogies depend on our skills in listening to and translating across different disciplinary languages, our willingness to keep experimenting, and our commitment to "making the invisible visible."[6]

What is made visible when we think of critical pedagogy as a form of STS practice, and when we consider our various STS practices as forms of critical pedagogy?

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## Subsection Citations

When citing this paper, the hosts of the workshop are listed first (Shannon N. Conley and Emily York) with all authors then appearing in alphabetical order. To cite the manuscript in its entirety, please cite the collective authorship (as shown in the standard journal citation footer). To only cite a specific section of this manuscript, we recommend citing the authors of a section as follows:

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[6] This phrasing in this context comes from the panel that included and was named by Eleanor Armstrong, Shelby Dietz, Sharlissa Moore, Ellan Spero, and Aubrey Wigner.

## Data Availability

Data published in this article can be accessed in STS Infrastructures at: https://n2t.net/ark:/81416/p4302j.

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