Things Matter: A Posthuman Empirical Inquiry into the Actualization of Gender in an Advanced Placement Biology Classroom

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Abstract

The purpose of this study was to investigate and document the conditions in which gender was actualized in a high school Advanced Placement biology classroom. The authors of this study begin with the assumption that equitable and inclusive science instruction should not reinforce or condition students into thinking about themselves as single beings with fixed identities. Rather, science instruction should support a view that students are changing beings who can become other. Given this assumption, we are obliged to provide opportunities for students to differently become. To this end, we turn to posthuman perspectives to inform our work in the classroom and provide the theoretical framework for our study. This posthuman onto-epistemological perspective decenters the human and instead foregrounds the co-constitutive and intra-active nature of our relationships in and with the world (Jeong et al., 2021). We take up Barad’s (2007) notion of entangled agencies where things and humans exist in a state of intra-action that is often a state of mutual constitution, where things and beings become something different. We also draw on scholars of new materialisms to examine how things matter in the actualization of students’ gender. Our study traces how gender followed unpredictable lines of flight and shows what gender could become. Using these theories to explain our findings we offer a new concept for the science classroom, students’ subjectivities-in-motion.

Keywords: Posthuman, high school biology classroom, post-identity, subjectivities-in-motion

Introduction

Science is often understood as a culturally-mediated way of thinking and knowing, and science learning is often understood as the engagement with its scientific practices (Brickhouse et al., 2000). However, the way in which students participate in school science can also be influenced by how they view themselves and whether or not they consider themselves to be the type of person who can engage with science (Brickhouse et al., 2000; Godwin & Potvin, 2017; Hand et al., 2017). Nasir and Hand (2006) posited that individuals learn to form and re-form their social relations within and across communities, as they gain or lose access to different sets of practices and roles. Extending this notion of learning to science classrooms, we should expect to see students negotiate and manage their participation, as well as the participation of others, in and across cultural practices, thereby positioning themselves and others through social, cultural,
and linguistic practices in and beyond these classroom spaces. As authors of this study, we argue that equitable and inclusive science teaching should not condition students into thinking of themselves as a single being, but rather as students who are constantly changing and who can become other, writ large. We also argue that an equitable and inclusive science learning environment should provide the conditions under which students can “become differently”.

The existing scholarly work in science education highlights identity as a mediator of learning (Archer et al., 2017; Barthelemy et al., 2016; Carlone et al., 2015; Godwin & Potvin, 2017). This literature suggests that the tension between student agency and the structure of the classroom practice is a significant factor in the formation of a student’s identity as a learner. While an increasing number of studies in the field of science education provide insightful accounts of how identity categories can play a role in the opportunities for learning made available for the students, scholars still know very little about how science norms and conventions are negotiated by students and teachers at the level of immediate discursive-material classroom interactions. Thus, equity scholars in science education, like Haverkos (2012), call for paying close attention to aspects of girls’ science learning experiences, such as issues of power and the underlying assumptions of science concepts and their interpretations. To help us pay close attention, we turn to posthuman onto-epistemological perspectives which decenter the human and thus foreground the co-constitutive and intra-active nature of our relationships within the world (Jeong et al., 2021). With this posthuman perspective and an orientation towards equity science education in mind, we designed our research to study the conditions under which gender in a high school Advanced Placement biology classroom played a role in how students negotiate activities in their day-to-day that might support or hinder an array of becomings in the science classrooms.

**Theoretical Framework: Theories of New Materialism and Assumptions**

The posthuman perspectives our study draws on are mainly those of new materialism as presented by Barad (2007) and the theories of Deleuze & Guattari (1987) around the relationship between difference and identity. Barad (2007) discusses the notion of entangled agencies where things and humans exist in a state of mutual constitution, or *intra-action* at the intersection of materiality, ontology, and subjectivity. In other words, Barad (2007) suggests that through intra-action, things and human are no longer the same as they were before they came into contact; instead, when they are fused, they become something different. Deleuze and Guattari’s (1987) assemblage theory asserts that assemblages are relational, multiple, and heterogenous, thus all members of an assemblage (both humans and non-humans) are significant to its operation. One might think of assemblages as ecologies. This concept can also be understood, in part, as a realization that humans are not at the center of everything which grounds students as actors in assemblages of relations. Further, assemblages are productive and dynamic through a process of “territorialization” and “de-territorialization”, which is the ordering of bodies in assemblages whether that may be joining together or breaking of heterogenous bodies.

Assemblage theory also posits that an open-ended set of “capacities” that exceed the properties of actants, emerge from the relations among the actors (Deleuze & Guattari, 1987). In other words, capacities emerge from the interactions of the actors in an assemblage. DeLanda (2006) defines “properties” as “given and may be denumerable as a closed list,” while capacities are not given and “may go unexercised if no entity suitable for interaction is around – and [these] form a potentially open list” (p. 10). In this study, we accept these definitions. We also associate
properties with what qualitative researchers’ study, since they are qualities that can be examined. Capacities, as we understand them, are the potential actions of an actant may take based on its properties.

Closely related to territorialization and de-territorialization, and significant in this study, is Deleuze & Guattari (1987)’s concept of “lines of flight”. Bazzul and Kayumova (2016) assert that lines of flight can “carry the promise of new possibilities and new connections” and “engage with other multiplicities…capable of giving birth to new lines of flight” (p. 288). We draw on the notion of lines of flight to consider the movement, thinking, or action of actors (both human and non-humans) that may move away from the apparent or the actual towards the virtual, multiple, or what has yet to become. In other words, following students’ lines of flight as actors in the science classroom, we hope to trace their becomings towards something new or towards what is yet possible.

Our “new material/empirical” inquiry examines the conditions under which the socials, as Latour (2005) calls them can be assembled, re-assembled, territorialized, or re-territorialized. According to DeLanda (Personal communication, February 27, 2018), gender is an abstract category that has been turned into reified generalities. Latour (2005) would classify gender an “easy social” because it is a collection of ideas that have already been “black-boxed” or bundled together (p. 165). A “difficult social”, the one we examine in this study, looks for the new that has not been assembled together—yet. Thus, our research framework operates with the following assumption: students’ science identity is not necessarily fixed or stable, for they can negotiate their identities as they partake in the cultural practice of school science. We value defining students’ science identities that are made through the observations of students’ performance in, by, and through the relations with other entities in the science classroom assemblage and by how students interact with each other. Thus, we would not define students’ science identities outside of their performance or the interactions. For us, the notion of students’ science identities grounded in posthuman perspectives opens up new possible social and material-discursive ways for both teachers and students to understand students’ becomings. To that end, our study asks the following research question: What are the conditions under which gender can become actualized in a high school biology classroom?

To address the research question, we use the term gender as an entry point to understanding students’ experiences with school science, however, like Derrida (1967/2016), our definition of gender is under erasure until we can observe how gender actualizes through the interactions within the science classroom assemblage. We do not ask what social structures exist, such as race, gender, or class, that might impact the way a school science classroom can be re-figured. Instead, we ask what might the actants (both humans and non-humans) become that could impact the way the socials of the science classroom are assembled or re-assembled? Thus, this study focuses on what actants (both humans and non-humans) mobilize and assemble to actualize their gender capacities and the how.

Methodological Framework: Posthuman Empirical Inquiry and Assumptions

Conducting a posthuman empirical inquiry is challenging, for the reasons Massumi (2010) indicates, “the new cannot be described, having not yet arrived” (p. 3). To address this methodological difficulty, we decided that actor-network theory, an ethnographically-informed method of description, was the best methodology for this study (Latour, 2005). We rationalized
that a methodology taken from actor-network theory would allow us to address the research question, remain open to how gender could become actualized, and allow us to examine and describe the day-to-day material-discursive interactions at a minute level. As a methodology, actor-network theory is a specialized tool to describe something that involves an incredibly demanding and thorough method of description and that pays empirical attention to the ontological multiplicities of the actors (both humans and non-humans). According to Latour (2005), producing a painstakingly thorough description is central to avoiding reifications of the social. Thus, we followed both the human and non-human actors’ lines of flight and examined the multiple associations that actors and actants formed to investigate what concepts/behaviors of gender that get produced and what actants become.

Drawing on MacLure’s (2013) work on glowing data, we thoughtfully use the term “data” as a way to deterritorialize or remove the limitations the word brings to a posthuman inquiry. MacLure (2013) suggests that “data cannot be seen as an inert and indifferent mass waiting to be in/formed…. [Data] can be seen, or rather felt, on occasions when one becomes easily ‘interested’ in a piece of data” (p. 660). In line with moving away from humanist assumptions that undergird the logic of representation, the notion of glowing data enabled us to examine and describe lines of flight that actors participating in school science may have taken or took (Jackson, 2017; St. Pierre et al., 2016). While St. Pierre et al. (2016) advise scholars to “read and read and read”, MacLure (2013) urges scholars to pay close attention to things that start to glimmer (p. 106). The emergence of glowing data is not something that is under our conscious or intentional control as analysts; rather, it is something that arrests or intensifies our gaze, making us pause or burrow inside it.

**Study Context**

Our study was conducted at an academically high performing, public science, technology, engineering, and mathematics (STEM) school in the Southeastern region of the United States. Students at this school were held to high academic achievement standards in STEM. Advanced Placement (AP) courses in the sciences were taken by 70% of the students, which was 50% higher than the reported statistics of the district. Of the students who take AP courses, 84% take the AP exams with a pass rate (that is, a score of 3 or higher out of a possible 5) among test takers of 96%, which is 66% higher than the reported statistics of the district. Ninety one percent of the students at this school enter a 4-year college as compared to 75% in the district. Thirty four percent of the students are on a free and reduced lunch program. Student demographics consist of 44% Asian, 23% African American, 20% White, 10% Hispanic or Latino, and 3% multiracial. The ratio of boys to girls is 60:40, which was also representative of the students mix in the AP biology course that was central to this study.

**Field Observations and Interviews**

This study described here was part of a year-long study during which the first author observed the Advanced Placement biology classrooms and interviewed the students who were entangled in the encounters. In this paper, we focused on the two students involved in one encounter entangled with the laboratory sink. We employed the following processes in our posthuman, empirical inquiry: (1) An examination of the conditions under which the capacity of gender is actualized, through field observation of the day-to-day material-discursive interactions in a high school Advanced Placement biology classroom. Entry points for field observations included descriptions of interactions or encounters between/among all actors including physical behaviors.
and gestures, verbal behaviors and gestures, researcher’s musings in the moment, and theoretical musings in the moment. (2) Guided by the concept of glowing data, students and the teacher who became involved in interactions and encounters were selected for conversations and follow-up interviews. Conversation prompts began with general questions such as, can you tell me about your experiences so far in AP Biology? General questions were followed by more specific questions such as, can you tell me more about when...[ex. You were doing an experiment with your lab partner? Could you elaborate on what you just said about that experience?]. Follow-up questions arose if further clarifications were needed. (3) Reading and re-reading field observation notes and texts and writing about the glowing data that emerged. These writing tasks took the form of accounts that illustrated students’ experiences with school science. Our accounts or vignettes were created from this three-part process.

**Findings: An Account of When Gender Glows**

The following vignette is used to present an account of an episode that illustrates discursive-material triggers and the ways in which both human and material actors shape these interactions.

“*Kenny, you need to be called out!*”

**Actors involved:** Mrs. Richards (the teacher), laboratory sink, Rue (female student), Kenny (male student).

Mrs. Richards (the teacher) ran her laboratory section of the Advanced Placement biology class with a set of routines. Her routine of content delivery, review of lab protocol, and inclusion of a hands-on experiment was produced time after time for each lab. One particular lab session on cellular respiration was no exception. With only a few minutes left until the bell rang, Mrs. Richards called for the attention of her students and reminded them,

“*Seven minutes! Start cleaning up, everyone.*”

Seconds prior to Mrs. Richards’ instruction, all students were working towards the completion of their science experiment. The agreement among the students for achieving equitable and inclusive participation was observed through the actions of turn-taking throughout the experiment. Mrs. Richards never explicitly instructed her students to take turns. Turn-taking was a protocol the students chose to follow themselves. Students talked with each other with the purpose of dividing up the experiment’s tasks. They routinely asked one another if anyone preferred a specific task. These types of conversations were no different during this particular lab experiment. The student bodies were evenly distributed around the laboratory table and the physical site of the experiment, which was also where a laptop was typically located. The school laptop was connected to the pressure probe and was used by the students to collect graphical data as the pressure inside the pressure flasks fluctuated. Students again took turns in sharing responsibilities and tasks required to complete each step of their lab. The established pattern and interactions of student bodies during the laboratory experiment were relatively stable.

I (first author) was standing next to the group that included Rue and Kenny. Rue is an African American female student and Kenny is an East Asian American male student. I noticed that the beakers, pipettes, and various lab equipment they used during the experiment were thrown in the sink. Dirty paper towels, melting ice cubes, spilled water, etc. were scattered.
messily around the lab table. I heard Mrs. Richards’ verbal instruction to “clean up the experiment.” The teacher’s instruction was said out loud and heard by the students. The moment the teacher’s words were spoken out to the class, those very words acted on the students—they seemed to exert force on the students. To comply with the verbal instructions, the student bodies, including Rue and Kenny, began to mobilize and move around the site of their experiments and around the laboratory sink. There were four long rows of black, epoxy resin laboratory tables with one sink per row. Each sink functioned as a place for producing and re-producing a specific role: washing the beakers and lab tools.

The very moment at which Mrs. Richards’ verbal instruction to “clean up,” was introduced, the equilibrium of the laboratory practices was disturbed. The very act of “cleaning up” became an assemblage of sociocultural norms and assumptions associated with “doing the dishes”—a domestic role generally assumed by the women in a household. In that instance, the pattern of relations between the student bodies were re-problematised. The “clean up” event began to create patterns of relations that were generally typified by gender in the laboratory space.

I noticed Kenny sauntering away from the laboratory sink towards the door. A sense of tension was evident between Rue and Kenny who were in the same laboratory group. A gender struggle seemed to emerge over who was going to “do the dishes.” It materialized around the sink. In this moment, the sink stood out from the backdrop of the numerous laboratory equipment, cabinets, drawers, etc., and imposed itself as a catalyst in the array of physical bodies around it. Its presence offered students a choice to either comply or not with sociocultural norms, or to comply or not with socio-feminist norms.

Kenny (the male body), sensing this struggle, moved away from the sink and walked towards the door, which in itself worked as the barrier that territorialized the physical spaces between the lab space and the social space (i.e., the hall way that allowed playful socialization among friends). Rue (the female body), upon noticing Kenny who was standing closer to the door, shouted out,

“Kenny, you need to be called out and exposed. You thought I was supposed to be doing the dishes. Come back here.”

Rue’s voice and her words “doing the dishes” pierced my ears. On the margin of my notepad, I wrote in capital letters, SINK and underlined Rue’s words.

Kenny sheepishly, yet quickly, walked back towards the sink and exchanged words of banter and laughter with Rue. Rue moved aside from the sink to make room for Kenny and re-established the pattern of equal participation. The established pattern of relations for equitable participation was re-imposed around the sink, a site where the assumptions of gender roles were contested by Rue, and the asymmetric relations constituted according to gender were de-stabilized and rejected in that very laboratory space.

Repeatedly, I observed that the act of conducting an experiment ended with the act of saving the results of the experimental graphs on the laptop. When the graphs were saved, the laptop was closed shut. Once the students were finished with their experiments, they picked up
their laptops and walked towards the door, out of the lab and into the hallway where the chatters that were not related to school tasks were permitted among friends.

In the hallway, the seating area was wide and open with a large panel window that allowed sunlight to come through. By contrast, the lab with the four long, epoxy resin tables limited space to move about the room. Students had to stand, as there were no chairs in the lab. However, in the hallway, students could sit around the available round tables that looked like the coffee tables that you might see at a coffee shop, or sit in the polka dot design lounge chairs that you might see in a hotel lobby. There, they would engage in activities that were not related to conducting an experiment. As soon as the laptop was packed up and shut, and the lab bench was no longer a site of doing a science activity, the tensions that I observed between Rue and Kenny dissipated.

Later that week, in my follow-up conversation with Rue, I asked her about my observation of this particular interaction towards the end of the lab experiment. She explained,

“I remember that day. Kenny was just strolling around doing nothing. I felt like, look, the least he could do was help me clean up whether he wanted to or not. As a female and as a minority in this school, I feel like at some point some of the boys do think it’s acceptable to do certain things. Maybe it’s the person that I am, but I’m going to say, ‘No, that’s not acceptable. It’s not right.’ People become harsh with me because I call people out. I’m just trying to, as a person, as a human being, help other people improve. Even if that means I have to call you out and tell you that you need to clean up. Kenny and the boys were just strolling around and having a little fun when we were doing the cleaning up. What’s he going to do the next time something happens and somebody else is cleaning it up, but you are not doing anything. Maybe it will incline you to be like, ‘maybe I should go and help out.’ It’s just that simple stuff like that.”

In the next section, we focused on the interpretations of this encounter.

**Interpretation**

Our interpretation of the event we have described suggests that things mattered in the actualization of gender.

The account of when gender glowed showed the power of things. Mrs. Richards’ clean up instructions had transformed into Rue’s words of “doing-the-dishes”, and the physical object, the laboratory sink, became the catalyst that actualized gender in that specific moment. The power of things to shape and direct assemblages was illustrated in other situations too. For example, the door from the lab to the hallway functioned as a physical barrier to territorialize social space and a science activity space. The laptop also played a role in territorializing the two spaces at the even more local and minute scale. The laboratory sink, as a central actor in this assemblage, was a mediator, but not a weak one. It performed as a tool to reproduce a social convention of gender. In other words, the sink actualized the elements of what gender could be in that very particular, local interaction.
In this account, the assumptions of gender roles were contested by Rue. The asymmetric relations constituted according to gender were de-stabilized and rejected in that very laboratory space. More than likely, the original and initial concerns of Rue, as well as her classmates, were focused on completing their lab experiments as the class period was coming to an end in seven minutes. It was not until the very end, when it was time to clean up the experiment that Rue felt something was “not acceptable.” Though Rue did not use specific words such as gender or inequities etc., she made the distinction between the “the boys who were strolling around” and the “we” who were cleaning up. Rue’s words disturbed the gender inequity that Rue felt and that Kenny sensed. In the context of the science classroom, Rue was an equal participant in the lab experiment with her male partner, Kenny. When she was positioned by Kenny in this context as someone associated with more widely accepted female sociocultural norms and expected to do the dishes, she corrected his assumption.

This study uses theories of new materialism to understand how things can catalyze and actualize students’ gender identity in the science classroom. While other forms of materialism can explain some aspects of human-object interaction, we agree with Latour (2005) who found that “[n]one of them are sufficient to describe the many entanglements of humans and non-humans” (p. 84). To the best of our knowledge, this study is the first to theorize the power of things to mobilize gender in science education. The intersection of encounters between humans and things such as Kenny and Rue with the sink is where humans and non-humans “slip-slide” into each other and demonstrate their agential and transformative capacity on one another (Bennett, 2010, p. 4). Both humans and non-humans matter in their continuous material exchanges with each other in producing the social; in changing each other.

In examining this glowing gender data, we observed students create narratives through their interactions with materials in the science classroom. Within these intra-actions, both the students (especially Rue, the female body) and the objects became something different. These narratives could be unspoken as these actions and practices could have never been brought to the forefront of everything that was happening in that science classroom. However, these narratives could also be spoken out loud, brought to the forefront, and demand attention to these inequities, as seen through Rue’s words about Kenny’s assumption about who was supposed to do the dishes. In the glowing data on gender, the things and students could not be separate, but became entities that constituted a mutually new construct of what gender could become and what students could become in that very moment. It also demonstrated a material-discursive process of becoming during which things and students played an equally vital role in the production of what gender could be in that very specific moment. The process was both material and discursive because the actions of the actors alone were not the only aspect to which the researcher paid attention. The actants were entangled in intra-actions, but students and the teacher were already always using other discourses available to them in the classroom. This study showed that things, such as the lab sink, became the catalyst in actualizing the capacity of gender in these encounters. However, more often than not, the spoken words of the human actors helped make the actualization of gender visible.

Our interpretation of the event further suggests that the actualization of gender followed lines of flight that were unpredictable.
Building on Deleuze and Guattari’s (1987) notion of a line of flight, as a movement, even an escape, in which an action, a word, a concept or a thing is changed or transformed, together with Fournier’s (2014) notion of gender dysphoria and unrealized potentials for reimagining gender, we realized that students’ ideas about gender and another’s identity can change. As Fournier (2014) puts it, when “a supposedly familiar landscape is blurred by the transposition of gender-signifying marks from one milieu to another, when the socially determined coordinates of familiarity-identity-gender no longer add up to a legible (legitimate) pattern, when materiality itself escape[s] the frame of representation, because this frame is built on gender binarism” (p. 121). In this vein, the AP biology classroom provided the context within which the capacity of gender could become actualized, resisted, or negotiated. Things catalyzed a transformative moment in the case of the actualization of gender involving Rue, Kenny, and the laboratory sink. The laboratory sink catapulted movements or ordering of the bodies that took lines of flight that were quick, sudden, and in motion such that an inclusive and equitable science learning activity was transformed into a gendered and inequitable activity. In this sense, Rue’s science identity was always in motion, and took on different subjectivities. Similarly, in 1993, Kathy E. Ferguson, theorized the notion of mobile subjectivities. By this she means the maintenance of agency without the reliance on a stable locus of one particular identity category. To illustrate this idea, Ferguson (2013) gives the example of a businesswoman who negotiates diverse social relations in day-to-day activities while being on the move and taking on multiple positions and embodiments. In the context of science teaching and learning, science identity is related to Ferguson’s mobile subjectivities. For our study, we prefer the term subjectivities-in-motion because we employ theories of new materialism grounded in posthuman perspectives. It also suggests the notion of students’ science identities that have been reimagined and re-theorized through relational ontologies always already in motion.

**Conclusion**

This study examined conditions under which the capacity of gender could be actualized through discursive-material practices catalyzed by things that were not only assembled in different ways to fashion encounters between bodies, but also allowed for transformative lines of flight. To that end, our posthuman inquiry illustrated the power of things in the actualization of gender. It also illustrated how the local interactions of actors (students, the teacher, things in the science classroom) understood as lines of flight allowed gender to escape from its black-box construct. In conclusion, we suggest that notions of subjectivities-in-motion, such as gender-in-motion, could be used in other classroom settings by teachers to help students understand the relational effects of relations shaped through practices.

By being careful not to impose “the social” as something that was monolithic, predetermined, and stable, we were able to focus on the local interactions and empirically observe and describe these nodes of negotiations. In doing so, we recognized that even the smallest interactions mattered because someone, likely a student, is negotiating that space because of their perceived identity in the science classroom. This study not only described the conditions under which gender was actualized but the actuality of what students did and acted in response to those conditions that posed inequitable science learning conditions. While Haverkos (2012) cautioned that there are still gendered disparities within science and science education that “play out in a number of cultural and material ways with girls still lagging behind on standardized science tests, gaining fewer science degrees overall, holding fewer science positions

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for less time,” we see our study, in small measure, as addressing her concern. It showed that material things can make opportunities available to actors for dealing with these encounters openly and directly.

Documenting these localized interactions when students respond to gendered encounters can be used as a tool by science teachers to heighten their awareness of gender issues in their classrooms and to attune themselves to actualizations of gender in places that may be often unpredictable. Using these encounters that draw on theories of new materialism offers new possibilities and insights for future research and practice in science teacher education, especially as we continue to push back against the black-boxes of Gender and Race with the capital G and the big R. We intend to continue our research with the aim of reimagining notions of an actor’s multiplicities, subjectivities, agency, and power as effects of relations within the context of school science.

References


