Probing beyond the biology: Centering a relational ontology in middle-school science modeling towards Rightful Presence

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Abstract: Modeling science phenomena serves as a tool to support science practices, where classroom environments and youths' relations with each other and those in positions of power shape how the activity unfolds and what models are created. Grounded in a relational ontology, we build on justice-oriented approaches to studying youths' learning towards their Rightful Presence by examining the expansive and political ways of knowing youth draw on while modeling. We followed a group of four middle-school youth and traced the human-human and human-more-than-human powered relations that shaped their models of short and long-term stress created across two multi-day lessons. We illustrate how models emerged as more-than-human entities with identities shaped through youths' intra-group, student-teacher, and human-more-than-human relations, entangled with who and how youth are in and with this world. We also argue ceding power to youth to re-author their and their models' rights supported more expansive understandings of youths' learning.

Introduction:

"Developing and using models" as outlined by the *Next Generation Science Standards* encourages learning science by engaging in embodied practices that integrate disciplinary content and processes, amongst other epistemic considerations (Gouvea & Passmore, 2017). In classrooms, models are considered representations of phenomena that serve as a tool to support learners' inquiry and exploration practices as they engage in sense-making around science phenomena (Guy-Gaytán et al., 2019). However, modeling is a social activity where classroom environments, pedagogical decisions, and youths' relations with each other and those in positions of power shape how the activity unfolds and what models are created (Shim & Kim, 2018). Both the act of modeling and the model created are not neutral processes or products, instead shaped by and through powered dynamics. While there is emerging scholarship that examines how social relations shape modeling practices, Schwartz et. el. (2022) argue that we need to be more explicit about *how* powered dynamics shape modeling activities so that we can support more "expansive, meaningful, and equitable modeling practices" in classrooms (p. 1087). Our study builds on this call by examining the sociopolitical and sociocultural powered dynamics that shaped how youth engaged in modeling practices in ways that led to the emergence of a model as a relational onto-epistemic entity. We develop expansive understandings of youths' learning to illustrate the "dimensions of knowing [that] are not currently valued in modeling competency frameworks and assessments" (Schwarz et al., 2022, p. 1089). Given calls for an expansion of our understanding of modeling and modeling practices, we learn from Indigenous scholarship to highlight the how youth are already engaging in these expansive and political ways of knowing when modeling in science classrooms. We ask: *How do powered human-more-than-human relations shape the emergence of a model on short and long-term stress created by middle-school youth?*

This work is grounded in a relational ontology, recognizing humans as existing in and with the world (Marin & Bang, 2018). From this purview, knowledge creation emerges in relation with the More Than Human (MTH; Bang et al., 2015) – in our case, the MTH in the classroom included laptops, digital tools like jamboard, poster papers, markers, etc. Through interaction analysis (Jordan & Henderson, 1995) we followed a group of four youth who named themselves the 'GLAY' group, making biology models of short-term and long-term stress across two multi-day lessons. We present three episodes to show how their poster-paper models emerged. Per the NGSS-aligned curriculum, the science content learning goal was for students to 'develop and/or use a model to describe phenomena'. We traced the powered relations that shaped the first paper model (of short-term stress) into 'GLAY - a genderless alien, everything and nothing at once, the center of the universe' and the second paper model (of long-term stress) into 'Maria/GLAY Jr. – a universal Goddess and GLAY the second'. When reflecting on the unit, the youth described their group and models as relations across space and time, where who they were as individual humans and as a "mis-functional Spanish family" group were not separate from but emerged in relation with and through their intergenerational family of paper models. Through this study, we illustrate how models were not just neutral tools for reasoning about science phenomena, but MTH entities with identities shaped with and through the youths' intra-group, student-teacher, and various human-MTH relations.

Theories that inform this work

We learn from Indigenous ways of knowing, to shift from a focus on human action to the relations between and within humans and the MTH world in our understanding of how reality emerges (Bang et al., 2015). Our understanding of the MTH is framed through braiding (Kimmerer, 2013) ways of knowing in Turtle Island (Marin & Bang, 2018) with Rishi's ancestral knowledge systems to reflect multiplicities and resonances in how we understand our experience in and with this world (Krishnamoorthy, 2023). Focusing on relations and the MTH as a unit of analysis helps us "expand understandings of how experience is constructed, and knowledge is generated as people interact in/with place" (Marin, 2020, p. 281) and therefore attend to human-human *and* human-MTH relations in knowledge creation as a whole-body activity across time and space. In doing so, we "recognize a multiplicity of histories, foster mutuality rather than extraction, and support theories that account for the role of more-than-human relatives in human development and learning." (Marin, 2020, p. 309). We also recognize our responsibility to learn from Indigenous scholarship as settlers on stolen lands, and work to resist the (re)production of colonial ways of knowing in how we study learning (Krishnamoorthy et al., 2021).

Guided by the Rightful Presence framework (RP; Calabrese Barton & Tan, 2020), we attend to how power shapes human-MTH relations through close attention to the ways in which historically sedimented powered dynamics are resisted and/or reauthored in classrooms. The RP framework takes a critical-justice oriented stance, challenging the positioning of youth as outsiders (guests) in classrooms where teachers are the hosts who author and extend rights to youth (to engage in practices such as modeling). Extending rights to youth and 'including' them into already sedimented classroom norms and practices limits the depth and breadth of youths' whole selves valued, in ways that can (re)produce existing inequities in education and the dominancy of canonical Eurocentric ways of recognizing learning (Tan & Calabrese Barton, 2020). The RP framework advocates for shifting guest-host student-teacher power differentials with adults working as sociopolitical allies by ceding power to youth, who reauthor their rights around ways of being and knowing such that their whole selves are valued in learning spaces. Using the RP framework, we trace sociopolitical and cultural powered dynamics that are de/settled in the classroom by examining human-human *and* human-MTH relations to illustrate the expansive and less extractive ways that youth engage in knowledge creation in science lessons.

Methods

This work was part of a grant-funded study that drew on critical participatory design research methods (Bang & Vossoughi, 2016) to create a 7th grade science unit focused on a health issue of concern to the local community – stress. The pilot unit was co-designed with eight youth and three teachers from local schools, and eight university partners from various institutions (Krishnamoorthy et al., 2022). Using a storyline approach (Reiser et al., 2021), the NGSS aligned unit drew on the RP (Calabrese Barton & Tan, 2020) and AIR (Chinn et al., 2014) frameworks such that youth learned about the biological phenomenon of stress as entangled with structures, policies, and procedures in the environment. Pilot data was gathered during Spring 2022, in one 7th grade science classroom, located in a sanctuary city in the NE-USA with 90.2% Hispanic students (2). Data included field notes, post-unit group interviews and video of whole-class and four focal youth's interactions: Batman, Ren, Star and Mario. Batman and Ren were long timers at the school, considered 'smart' by their peers while Star and Mario were new to the school that year. Youth had not worked together prior to this study. Adults included the science teacher (a cis-female Middle Eastern immigrant), a support teacher (a Black and African American cis-female), Rishi (a trans/genderqueer [they/them] South Asian) and Ravit (a Middle Eastern immigrant cis female).

Episodes analyzed were of youth modeling short-term and long-term stress (9 hours). Drawing on interaction analysis methods (Jordan & Henderson, 1995), we analyzed human-human and human-MTH interactions to trace the co-operative (Goodwin, 2017) construction of the models as emergent and non-neutral MTH phenomena in the classroom. Examining how youth built on, decomposed, and transformed each other's substrates (Goodwin, 2017), layered with an analysis of how settled guest-host relations were de/settled illustrated the powered human-human and human-MTH relations entangled with the modeling activity. The three hot spot episodes highlight: 1) Team GLAY, a human community shaped by relations with each other and the classroom, 2) GLAY the short-term model, a MTH entity shaped by youths' intra-group and adult-youth powered dynamics, 3) Maria/GLAY Jr. the long-term model, a MTH entity with personhood, part of an intergenerational family.

Findings:

GLAY: Mis-functioning Spanish family time

In the short-term stress lesson, youth reviewed evidence provided to them and built a model to show 'what happens inside the body that causes the sensations associated with short-term stress' (see Figure 1A). Youth were provided

the option of a Jamboard with a ginger person and some visuals (see Figure 1B), or poster paper to make their models. The short-term lesson was the first time Mario, Star, Batman, and Ren worked together as a group and GLAY emerged as the group's team name – created from the first letter of each youth's name.

Figure 1
A)Slide with instructions and B) Jamboard provided to youth
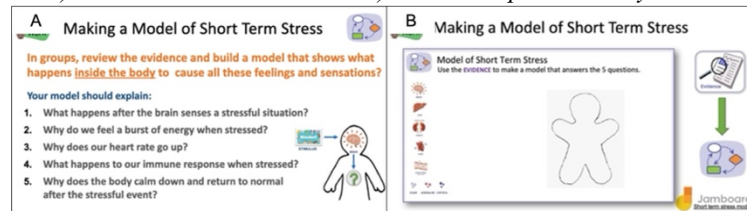
Initially, team GLAY encountered some struggles navigating their group dynamic, disagreeing about how to draw the head of the model. Mario suggested they trace his head onto the sheet of paper, but his head was too big in relation with the body they had already drawn, and the poster dimensions. While passing by Rishi commented:

[1] Rishi: Man, I love your group
[2] Ren: It's a. It's a. It's like a family.
[3] Rishi: Yeah, I like it
[4] Mario: It's a drama! Because they couldn't even trace my head really good!
[5] Star: Okay we good. What are you talking about you couldn't even do none of us!
[6] Ren: it's just it's just..it's just a family! It's just a very…. misfunctioning family
[7] Batman: okay you know I..I..
[8] Rishi: ((to Ren)) Aren't all families misfunctioning families?
[9] Star: I live in a Spanish household. This is worse. ((Rishi laughs and walks away))
[10] Batman: I like his brain. I like his brain ..it's too small.. You know it's fine I guess.

Rishi's utterance [1] affirmed the group's dynamic as desired [3] in the classroom space by; 1) Challenging traditional deficit framings of student discord during group work and 2) Reifying adult-student powered relations where adults author the forms of behavior allowed in classrooms. This substrate [1] was taken up by Ren who reframed it as "like a family" [2], transformed into a "drama" [4] by Mario because of his group mates' inability to trace his head onto the paper. Mario's utterance [4] and Star's retort [5] illustrated their group's "misfunctioning family" [6] dynamic, worse than the "Spanish household" [9] that Star lived in. Yet despite their arguments, their misfunctioning dynamic created a brain that may have been too small but was "fine" in the end [10]. GLAY emerged through human-MTH *and* human-human non-neutral powered relations. The poster enacted power in its relation with Mario by virtue of its dimensions rendering Mario's head a non-viable resource for creating the model. Rishi-youth relations (re)produced sedimented adult-youth power dynamics when they ratified the youth's intra-group (i.e., student-student) relations as desirable [1,3]. Furthermore, youths' cultural identities, histories, and family relations framed their dynamic as a family, "misfunctioning" and "worse" than a "Spanish household". This interaction illustrated the modeling task as not separate from their intra-group and teacher-student interactions, also involving human-MTH relations (i.e., Mario's head's-poster relation). GLAY emerged as a family through their powered relations with each other, the adults, and with the MTH (i.e., the poster) as well.

As the unit unfolded, meaning-making around GLAY as a Spanish family continued. Youth assumed roles shaping their individual relations with the MTH: Mario the artist, engaged in human-poster relations through which etchings on the paper emerged; Ren the "brain", who authored the messages on the model through human-curriculum relations, Batman the "getter'", who brought MTH resources (i.e., markers, etc.) into relation with the model, and Star the "heart", whose relations with the others brought decorative etchings of 'GLAY' into relation with the model. In this sense, the curriculum task, and expectations around what the model should be, the size of the poster, the quality of markers, and their intra-group and adult-youth relations, shaped who GLAY was as a family *and* the MTH entities that emerged (i.e., the models). Next, we illustrate how focusing on relations as the unit of analysis foregrounds youth-curriculum relations as shaping the emergence of models as MTH entities.

GLAY the original: A genderless, universal God and alien
As the short-term modeling activity unfolded, GLAY emerged not only as the group's team name, but the name the model they constructed – a genderless, universal GOD and alien (See Figure 2A).

Figure 2:
Short-term (A) and long-term stress (B) models
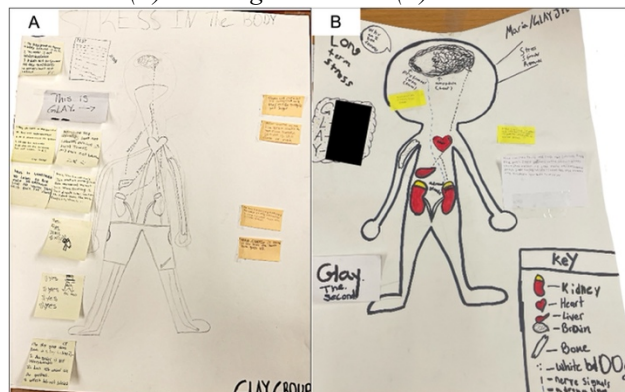
'GLAY' first emerged on the poster when Batman suggested, "instead of writing our names, we can just put our team-name". Then, GLAY was shaped into a 'being' – first a human, then a ginger person (i.e., genderless ginger cookie), then an alien – through the youths' relations with the instruction slide (See Figure 1) and their negotiating how to represent the being. When beginning the modeling activity, the Jamboard slide was open on Ren's laptop and Mario began to "pre-draw" a sketch of their model on a small whiteboard. Ren clarified to Batman that their task was to "make a model" "based off of this ((the slide)) about how the body functions when we're stressed". Ren's attention then shifted towards Mario's sketch on the whiteboard:

[11] Ren: ok Mario we're not gonna give him pants. We're just gonna
[12] Mario: ok he's naked then.
[13] Ren: yes he is naked
[14] Mario: blurred
[15] Ren: no we don't need to blur

With no pants [11], Mario's noting that the model would be "naked" [12] was ratified by Ren, indicating both youths were aligned in their authoring of the model as a 'naked' being. However, Mario's subsequent utterance that the model be "blurred" [14] indicated a disjuncture between how Mario and Ren had gendered the emerging model. To Mario the naked model – a gendered entity – would necessitate censoring to be appropriate for the classroom context. Ren however did not agree [15] as he later noted, "it's genderless, it's a cookie! You think you're gonna have private parts on a cookie?" That is, although Mario and Ren were aligned in their understanding of the model as a *being* of some sort, Ren drew on the representation on the slide (See Figure 1B) animated as a "gingerperson" by their teacher, to frame the model as a genderless cookie. Mario rejected this framing by voicing the disjuncture around the model's gender and personhood arguing, "I don't wanna do a cookie. I wanna do a person". The youth continued to argue until ultimately Ren resigned to Mario's persistence and the model was framed as a "person" (albeit still a "ginger person" [23] according to Ren) whose gender was under construction. Once the 'pre-drawing' of the model was complete, Mario held up the whiteboard to his groupmates and uttered:

[16] Mario: I put in extra details
[17] Ren: Why did you give him abs?
[18] Mario: what?
[19] Ren: Why did you give IT abs?
[20] Mario: oh.. that's how you call them?
[21] Ren: IT
[22] Mario: I never knew…
[23] Ren: it is genderless. It is a genderless ginger person. We call it a… IT. Them.
[24] Mario: There..((shows Ren the whiteboard))
[25] Ren: It's. it's non-binary.

When critiquing the 'pre-drawing', Ren authored the model as an "it" [19, 21] and "them" [23], building on his earlier positioning of the model as a "ginger person" who was now "genderless" [23] and "non-binary" [25].

Mario, less versed in pronoun use, expressed not knowing [22] and the interaction around the model's gender was driven though Ren's enacting power as a knower and author around gender, despite not having resolved the distinction between the model being 'genderless' [23] and/or 'non-binary' [25]. After this interaction, the group did not directly discuss the model's gender however the model emerged as 'genderless' through their negotiating the model's name. Star suggested "his name's gonna be GLAY", which Ren transformed to "GLAY the alien" because GLAY could be a "boy or girl" name, as noted by Batman. Therefore, GLAY the model emerged through the co-operative interaction between youths' relations with the curriculum slide, and their intra-group powered relations – Mario the artist insisting on the model's personhood, Ren authoring the model as genderless, and Star naming the model GLAY. GLAY the alien's identity was then ratified in the larger classroom space through the group and model's interactions with the adult facilitators the next day, when Rishi asked the group "what's gonna happen on this episode of the lives of GLAY?" Looking at their poster, Mario responded:

[26] Mario: I mx. I like the shorts. And then he says he's genderless. While.. and he says.
[27] Rishi: oh sorry I misgendered GLAY my bad
[28] Mario: [No he. No but I]
[29] Batman: [No it's GLAY is GLAY]
[30] Ren: No. And he keeps saying he ((points to Mario))
[31] Mario: Then. And then I'm saying that he's a boy and he's like [he's genderless.]
[32] Batman: [GLAY is everything]
[33] Ren: [GLAY is a. GLAY is an alien]
[34] Mario: [So they put him shorts]
[35] Rishi: ((looking at Mario)) GLAY is an alien!
[36] Ren: GLAY is the alien
[37] Mario: I know and then so then I put him like a blurred and then he's like. He's. Genderless.
[38] Rishi: ((Rishi laughs)) So wait. Aliens don't have gender?
[39] Batman: No. Just. He's everything.
[40] Ren: No!
[41] Rishi: I didn't hear you what? ((moves around in between Batman and Ren))
[42] Batman: He's everything ((nods yes))
[43] Ren: [he's eve. He's]
[44] Rishi: [He's everything! Woah!]
[45] Ren: He's at the ss.. GLAY is at the center of the universe
[46] Batman: Nothing but everything at the same time..
[47] Rishi: ((looks over to Batman with wide eyes)) Yo.. that's lit.

Mario's reanimation of the group's negotiations around gender [26] indicated the possibility of something unresolved for him, that he "never knew" [22] regarding gender and the emerging model. For Mario, the tension around the model's gender emerged in relation with representing the model's clothing [34] and Ren's authoring the model as genderless [31]. In the interaction, Batman and Ren positioned themselves as animators and knowers of GLAY's gender and identity and co-operatively constructed GLAY an alien [33], "everything" [32, 39, 42], the "center of the universe" [45], and "nothing but everything at the same time" [46], who was not to be referred to using 'he' pronouns [30]. Importantly, this interaction revealed how the youth's roles within the group and intra-group powered dynamics shaped how and who GLAY the MTH entity with personhood emerged. Batman and Ren were considered the 'smart people' of the group (animated – voiced – by Star the previous day) while Mario was the artist and, in this interaction, less of a 'knower' regarding GLAY's gender. Mario's concerns regarding GLAY's gender emerged through his role as the artist and shaped GLAY into assuming personhood through his decisions around the necessity to draw shorts [34], or whether to blur [37] certain regions of the entity. Ren and Batman built on these substrates through their powered authorship, co-operatively constructing GLAY's identity as an alien. GLAY the model's identity was also ratified through the adult's sociopolitical allyship towards youths' authoring their rights in the classroom space – through Rishi apologizing for having misgendered GLAY [27], re-animating GLAY as an alien [35], and legitimating their construction as "lit" [47].

The next day when youth continued modeling, GLAY emerged as an entity that didn't use pronouns, was just called "GLAY", and whose physical appearance was co-operatively constructed by gender and curricular expectations. For example, GLAY the model was shaped into being shoe-less, because as Mario noted "we can't put him shoes ms, because this is the part where the blood stream goes circle like you know?" as he traced his fingers along GLAY the model's extremities. Therefore, in addition to the youths' intra-group relations and adult-youth powered relations (human-human relations), the youths' relations with the curriculum (human-MTH

relations) shaped how GLAY as an entity emerged. In this episode we build on recent scholarship on youths' social relations that shape modeling activities (Shim & Kim, 2018) by illustrating how youths' intra-group, adult-youth, and individual and group powered relations with the curricular materials shaped the emergent model entity. Their model represented the required biological systems (i.e., short-term stress). It was also a MTH entity with personhood (or alien-hood) that emerged through powered human-human and human-MTH relations. Next, we illustrate how youths' relations with macro sociopolitical powered dynamics also shaped the model that emerged.

Maria/GLAY Jr.: GLAY the second, a universal Goddess

In the next lesson set, the youth read a story about a character 'Maria', who was experiencing symptoms of long-term stress. The group's task was to create a model of long-term stress based on evidence pieces that the character Maria encountered in the story. This modeling activity and the model's identity emerged through the youth and model's relation with the previous lesson on short-term stress, evidenced by the youth negotiating the long-term stress model's name. Mario noted, "since we're gonna do another model, we can name him GLAY Jr.". However, Batman and Ren were not convinced, and the group debated whether the model's name would be GLAY Jr., or GLAY the second (who wore a top hat). Ultimately, the long-term stress model emerged as a MTH entity shaped through the youths' relations with the curriculum and the story character Maria (human-MTH relations), Star's relations with Batman, Ren, and Mario and larger sociopolitical powered dynamics (human-human relations), and the model's positioning as the 'second' of its kind following GLAY the original (MTH-MTH relations).

[48] Star: Like GLAY had a small brain that means he had no thing like..
[49] Mario: He had. He was dumb now
[50] Star: Exactly
[51] Ren: Its not a he. it's not a the.
[52] Star: It's not a he, they or she
[53] Ren: universal God give them some respect
[54] Star: we might as well. we might as well give him a gender because like..
[55] Ren: Give GLAY the universal God uh God respect
[56] Star: GLAY should be a female
[57] Mario: GLAY? a FEMALE? Excuse me? ((pauses drawing, leans back, and looks at Star))
[58] Star: GLAY should be a female. There's already three boys and there's only one girl. ((moves forward, points to Mario, Ren, and Batman and then herself))
[59] Mario: FINE
[60] Ren: It's women's history month. Ya gotta..

Star's initial relation with and meaning-making around the model's head being too small to draw in a brain [48] was reanimated by Mario as the model being dumb [49]. However, Ren took up this substrate and transformed it into a correction of Star's use of GLAY's gender [51], reanimated and expanded by Star from "he or "the." [51] to "he", "she" or "they" [52]. Ren, looking for the appropriate way to address GLAY, built on Star's animation from using "them" pronouns [53] to no pronouns [55]. Star however, transformed Ren's negotiation of GLAY's gender into an opportunity where they "might as well give him a gender" [54]. While Star's reasoning for gendering GLAY was not revealed, she re-asserted that GLAY should be female [56]. In response to Mario's dramatized surprise [57], Star drew on her position as a female in the group as consequential towards GLAY being gendered as female [58]. Building on this substrate, Ren's utterance entangled "women's history month" [60] and in doing so, larger sociopolitical powered dynamics around female representation, with the emerging 'gendering' of their model. The model emerged as a female through its relations with the gendered dynamics within the human family – GLAY – *and* the macro sociopolitical dynamics and histories informing the institution of women's history month. As such, GLAY emerged as a "universal Goddess", named by Ren moments later.

The model's physical shape emerged through the youths' relations with the evidence sets, when deciding how much clothing the model would need, and how to depict neural signaling loss due to long-term stress. At the end of the lesson, the teachers instructed the youth to "add a title" – a model criteria (Rinehart et al., 2016) agreed upon by the class. They decided that "her" name would be Maria since they were modeling the curriculum story character's experience. Being the second model their group created, the youth deemed it important to place a notecard indicating the model was "GLAY the second" inscribing her name as Maria/GLAY Jr. (See Figure 2B). Unlike the short-term stress model, they wrote their names on the poster sheet, a symbol of their pride in their work. The youth noted that Maria/Glay Jr. illustrated who the youth were (through their initials on the poster) and served as a window into their memories of struggles as a Spanish family learning to work with each other, a tv-drama unfolding daily. Maria/GLAY Jr. was not just a neutral epistemic product (model) representing youths'

knowledge nor was it just a tool used to learn about stress. She was a MTH entity with personhood, a universal Goddess and the descendent of GLAY the original. Team GLAY's long-term stress model emerged through their intra-group and adult-youth (human-human) relations, their relations with macro sociopolitical powered dynamics, and youth-curriculum relations across this curricular unit (i.e., human-MTH relations across space and time).

Discussion

Centering a relational ontology in curriculum design and enactment supported the youth to continually engage in 'the right to reauthor rights', a Rightful Presence tenet (Calabrese Barton & Tan, 2020). While the science curricular learning task was to construct a model to first explain the biology of short-term stress and then long-term stress, the ways in which GLAY members engaged with their modeling suggested that they were probing for understandings beyond the biological phenomenon. They were simultaneously *modeling* – figuring out in real time – who they were, who they could be and wanted to be, in relation with whom and with what (i.e., configurations of human and MTH resources), as Spanish speaking youth in an urban classroom. Through a relational ontology, we suggest that the GLAY youth were engaging in *multi-scale onto-epistemological modeling*. That is, in their performing of the GLAY group, the youth entangled the following: a) their Hispanic identities with familial, playful repartee; b) their strength-based distributed expertise with the group work (Mario, friendly and tentative speaker but a recognized artist; Ren and Batman as the 'good science students' offering ideas, and Star as the friend-of-all leader who directs and oversees); c) their chosen spatial-material resources, including claiming the largest round table in the classroom on which they stuck a notecard with their name "GLAY" written on it, and preference for large poster paper and markers to draw a model (vs using Jamboard).

On another scale, the emerging creation of "GLAY the original as a genderless, universal God and alien" model of short-term stress suggested that the youth set much store on who and what GLAY the model represented, beyond the biological systems they were drawing inside the model. Here, GLAY further entangled and brought classroom epistemic discourse, issues of gender identity and (non)rightful presence as new arrivals. Their discussions of GLAY the model as "genderless", "non-binary", as "it", as "GLAY", is a continued thread that emerged from a prior lesson the youth grasped onto and elevated during this modeling activity. In the prior lesson, the class had discussed whether it would cause survey takers stress to disclose their gender, and whether the categories of "male, female, other" were marginalizing to people who identify as queer. Two members of GLAY also have same-sex parents. In these episodes, the youths' stance to depart from the normed heteropatriarchy of a default male Eurocentric scientific model was made starkly apparent. In addition, two of the GLAY youth were also recent arrivals to the school, suggesting an ontological thread in attending to tropes of power and alienation, rightful or non-rightful presence between the youth negotiating the identity of GLAY the model as a "universal GOD and alien" and their real-time, embodied experiences of figuring out how to fit in at the school.

Between short and long-term stress modeling, the youth explored stories as a part of the curriculum that fleshed out impacts of long-term stress on fictional characters one of whom was a Maria – a young Hispanic girl with younger-sibling care responsibilities. Long-term stress Maria/GLAY Jr. emerged from GLAY the original – a genderless, universal God and alien – held in dialogue with the Maria story, with whom the GLAY youth resonated. Star's decision to spotlight her lone female representation in the group with Ren's recognition that it was "women history month" led to a third scale of modeling as GLAY youth negotiated and collectively made sense of what it might mean for Maria/GLAY Jr. the model to be female, and Hispanic, instead of a genderless universal God and alien. The model was recognized as a MTH entity with personhood, and gendered and racial identities, both still a departure from the Eurocentric default white male model.

Implications

Struggles of gender identities and rightful presence are formidable sources of stress for youth in schools. The GLAY youth showed their wisdom in unabashedly making these embodied struggles (for some of them) central to a modeling activity on the biological phenomenon of stress. Their actions reflect their desire for authoring a Rightful Presence in middle school science, illustrated through centering a relational ontology. Who youth are, can be and want to be, with whom and what spatial-materials, are ineluctably bound up in the processes of epistemic meaning-making. In short, it is impossible to divorce ontology from epistemology, and it is imperative to attend to historical injustices and its contemporary reproductions through interrogating normalized science classroom practices and assumptions. With our study, rather than only considering scientific models as a tool for students to make sense of scientific phenomena, we argue for the need to understand models as deeply entangled with who and how youth are in and with this world. Furthermore, we advocate for acting as sociopolitical allies and ceding power to youth to reauthor both their and their models' rights in the classroom space as one way we can support this more expansive understanding of youths' learning and their world selves in classroom spaces.

Endnotes

(1) By examining human-MTH relations, we identify the many histories of coloniality (re)produced in science classrooms.
(2) Youth identified broadly as Hispanic, preferring more specific national identities (e.g., Dominican, Puerto Rican etc.).

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