STEM as Culture: Exploring exclusion and inclusion in mathematics and biology

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Abstract.

Finding a path for calculus in the biological sciences is not just about asserting an inherent place, but by enhancing and communicating the value of calculus. Thus, the key to a successful calculus is by reflecting on the culture of mathematics, the culture of biology, and the cultural space we create at the interface. Disciplinary culture is shaped by and shapes the disciplinary content we value, the language we use, and the way we treat each other. I draw on traditions of *testimonio* to share experiences, both personal and professional, in which the skills of boundary spanning between cultures were developed, critically refined, and empirically tested in the context of developing curriculum for calculus for life and environmental science.

Code switching and boundary spanning

> Like all people, we perceive the version of reality that our culture communicates. Like others having or living in more than one culture, we get multiple, often opposing messages. The coming together of two self-consistent but habitually incomparable frames of reference causes un choque, a cultural collision. (Anzaldúa, 1987, p. 78)

It was less than a decade ago that I was first introduced to the work of Chicanx scholar Dr. Gloria Anzaldúa. I was writing a duoethnography with my cousin on our journey as mathematics educators in the United States and the ancestral legacy of mathematics education we shared in Peru. It was more recently that I was introduced to Dr. Anzaldúa's work translingualing as she wrote about negotiating cultural borders from Mexico to the United States in La Frontera (Anzaldúa, 1987).

Like Dr. Anzaldúa, I grew up in two worlds - a father from South America and a mother from the United States whose ancestors arrived in the 1800s from Sweden, England, and Germany. My dad was Catholic and my mom was Protestant. My father's first language was Spanish, and my mom's first language was English. She nearly failed Spanish class in high school. As I was growing up, I did not realize that I was in Nepantla, learning how to bridge the gap between the

cultures of my parents. I consciously spent more energy navigating the gap between my parents' culture and the evolution of society. But in reality I have always been at Anzalda's La Frontera - a world away from the physical border, but at the cultural borders within our family.

At an early age, I understood that how I acted in church with my mom was very different than how I acted in church with my dad. Church services with my mom were about church hymnals and choir and gatherings were fun and loud, but focused around plays and craft fairs. Church services with my dad were in Spanish with a touch of Latin, ritualized praying and minimal singing. Church gatherings were all night parties due to quinceañeras with dancing and never-ending food. My mom's culture, the culture of British colonization, dominated my experience in the world. My dad's culture - *mezcla* of Indigenous and Spanish colonization imported from Latin America - was limited to a minoritized and underserved neighborhood of Providence, Rhode Island.

Later as I learned, researched, and taught at the interface of mathematics and biology through college and my career, I would unconsciously analyze and make decisions around the cultural norms of each discipline. It was natural for me to intentionally plan about how to fit in, how to dress and how to act, which jokes I could tell for mathematics audiences and which for biology, and how to anticipate power dynamics which might shape interactions. It was natural for me, because I had been expected to assimilate all my life, code-switching[1][1] as necessary.

To establish credibility among mathematicians, I would plan to discuss a proof or show evidence of long equations behind the model simulations I presented. To establish credibility among biologists at conferences, I only had to state I was a mathematician. But to establish credibility as a biologist, to biologists, I had to understand the context of biological questions, understand the epistemology of the field, and reasonably justify any abstractions to my models with reference to prior experimental studies.

As a mathematics PhD student at the University of Tennessee with a concentration in mathematical ecology and evolutionary theory, I spent many years in a Ecology and Evolutionary Biology department journal seminars. The last year I was there, at the beginning of the semester, we performed re-introductions for the new graduate students and faculty. When I introduced myself as a mathematics major, the ecology and evolutionary biology students who I had known for years were shocked. They did not know my primary department affiliation was

[1][1] Code-switching is a term used to describe switching between language and cultures. In marginalized communities it is often performed due to assimilation pressures as a matter of survival in hegemony (McCluney et al., 2019).

mathematics. At the time this was a great honor - a sort of proof of my mastery of code-switching.

To be able to successfully code-switch is to temporarily assimilate into a context and hide the presence of other identities. Since then, I have come to instead embrace Nepantla, an Indigenous idea introduced to mathematics education by Rochelle Gutiérrez (Gutiérrez, 2017). By being in the "in-between," one experiences a new space of possibility. While code switching was a matter of survival and a drain on energy, the experience of code switching in my upbringing gave me an understanding of culture that would later impact how I engaged in interdisciplinary STEM education.

To me collaboration between disciplines is more than just working on the same grant or paper. To me, collaboration in mathematics education and biology education has been about people working together. People with their own cultural histories, norms, and languages. People who have to learn how to value each other's contributions to STEM and STEM education and then find ways to collaborate around this shared vision (Diaz Eaton et al., 2023). Dr. Joe Redish writes about this extensively in his work between introductory physics and biology (Redish, 2012). Throughout this paper, I use a form of critical autoethnography, a *testimonio*, to share experiences and *conocimiento* which have shaped my approach to humanizing interdisciplinary STEM education and research (Quicke, 2010; Rodriguez-Campo, 2021).

Value and Language

As an assistant professor, I taught mathematics at Unity College - a small, undergraduate, private liberal arts college which trained environmental professionals. At the time I arrived, the college was undergoing a self-study due to a regional accreditation review. Some biology majors were considering eliminating Calculus I from the list of required courses (Diaz Eaton & Highlander, 2017). The reasoning: students were not choosing their program or major because they would have to take calculus, and either did not want to take mathematics other than statistics or did not have the prerequisites. Upon deeper probing, both biology students and biology faculty felt calculus was irrelevant to biology. This is not an uncommon conversation among biology and other majors which require calculus. There is plenty of research to illustrate how calculus has become an overzealous STEM gatekeeper (Ellis et al., 2016). Many biology departments have eliminated calculus as a requirement or have hired their own calculus instructor for a customized experience - like many biostatistics courses already.

Because of student interest, I had already been including more relevant biology applications in the calculus course. But now I had a new audience to please - major program directors. I set out

to create a calculus experience that also would deliver what program directors valued. First, I created a list of calculus topics and surveyed faculty across the programs to understand which topics were most important for their majors.

The results of my survey were disappointing. Very few topics were considered important. This was likely a fundamental contributor to the ongoing conversation to eliminate calculus as a requirement. But from a content analysis perspective, this made little sense. Prior conversations with all of these individuals indicated that population assessment and management relied on underlying theoretical dynamical systems models, modeling is a fundamental contributor to understanding climate change in the geoscience courses, and economics models are used in conversations about sustainability and resource management. I decided to follow up with one on one interviews with some of these program directors to ask why topics like "derivatives" were not listed as important.

I discerned a key difference in those conversations: understanding "derivatives" were not viewed as important, but understanding and describing "rates of change" was considered important. To mathematicians, these terms describe the same concepts. To our colleagues, scientists, and students, in life and environmental science, these terms are fundamentally different. "Derivatives" are perceived as a set of abstracted formulas and rules. "Rates of change" describes how these abstracted concepts are useful in their fields. Likewise, "first order differential equations" rated extremely low, but "feedback loops" rated extremely high. Redish and Kou describe these as differences in the "'dialect' of speaking math" (2015, p. 563). I incorrectly assumed my audience already had fluency in translating my dialect of math to their disciplines and could easily recognize the value of abstracted mathematics. They valued calculus, but more specifically, their dialect of calculus (Diaz Eaton & Highlander, 2017). See works of Diaz Eaton and Callender Highlander for the final version of the survey.

As a direct result of my new survey findings, instead of dismissing exponential functions as precalculus material, I contextualized exponential functions from a modeling perspective in Calculus I. We introduced geometric sequences and equilibrium first. Then later, after introducing the idea of infinitesimal difference, change, and derivatives, re-introduced the continuous analog - exponential equations. Together, we solved the mystery of why exponential functions matter; They are an alternate form of the simplest autonomous differential equation describing a situation in which the instantaneous rate of change is proportional to the current size or magnitude. This key idea is what sets the exponential curve apart from all other functions with positive first and second derivatives. It also explains why exponential functions are heavily used

in population dynamics - because populations like bacteria continuously reproduce in proportion to their current number.

I collaborated with Dr. Callendar Highlander who also taught a newly revised biocalculus course at the University of Portland and Dr. Aikens, a qualitative researcher, to analyze student data from across both schools' new biocalculus students. One interesting surprise was that on pre- and post- course surveys, students did not report significant changes in their belief of mathematics' utility-value to biology. However, it was in the qualitative responses, where they were asked to describe how mathematics is used in biology that we saw the biggest and most significant changes. Students used more specific examples and showed a newly gained fluency in discussing mathematical terms in biology (Aikens, Highlander, & Diaz Eaton, 2021).

One year I had the opportunity to co-teach Spanish. Reading the literature on teaching foreign languages allowed me to reflect on mathematical translation as linguistic practice. It is not enough to teach vocabulary and grammatical rules. You must also understand how to put these together in a meaningful sentence in the context of a conversation which takes place within a particular culture. Over time, you can move from translating words to translating ideas - possibly the difference in relying on Google Translate versus a trained interpreter. We read Pablo Neruda, compared the Spanish and English versions, and discussed possible alternate translations to preserve the word choice, the ideas, and the art - both visual and auditory - of the poem. I use the example of *saber* and *conocer* to illustrate. These are two words that mean"to know" in Spanish. We use *saber* when we are typically talking about knowing a fact or learning a skill, and we use *conocer* when knowing a place or person. It is not enough to teach calculus as a collection of definitions and algebraic rules and ask "*¿Qué sabe?"*. We must focus more broadly on translation, between representations and dialects, between disciplines and cultures and ask "*¿Cómo lo conoce?"*. We already "know" this linguistically in Spanish-speaking cultures, as accumulated knowledge is referred to as "*conocimiento"* or wisdom.

Modeling and Microaggressions

In 2015, collaborators and I convened a working group on the teaching of modeling at the National Institute for Mathematical Biology and Synthesis. Our working group represented researchers from mathematics, biology, math biology education, physics education, science education, math education and professional development. By the end of our first in-person meeting, it was clear that we were circling around something fundamental - we each had different understandings of the words "model" and "modeling" based on our (sub)disciplinary epistemologies. Those in biology defined "modeling" in ways that implied that datasets were

involved in the process of creating a model. Those in mathematics defined "modeling" in ways that implied that a dataset was unnecessary in the creation of a model. Translation of language was not the issue - it was that concept the language conveyed that had a different meaning in each cultural context.

We coined the term "disciplinary microaggressions" - an act of exclusion that may or may not be intentional and occurs as a result of disciplinary cultural power dynamics and language - from our own *testimonios*. During the working group, I recounted how I was told that one of my research students was not eligible for the research award because their modeling project did not require them to collect their own data. My colleague recounted how her department criticized her bioinformatics research using data science because it did not follow a "scientific method" in which there was *a priori* development of a testable hypothesis. I also admitted how I have been the perpetrator of microaggressions myself. I was visiting an institution to give a talk and one biologist, who knew I was a mathematician, enthusiastically offered to show me their data. In response, I said "I do not work with data - I worked with theoretical models," which effectively shut down the conversation. I did not intend to cut off the conversation - at the time I had limited experience with data fitting in my own research. I did not consider myself a statistician and thought I was helpfully clarifying a distinction in fields. Building a theory of disciplinary microaggressions gave me a new mental model to make sense of my prior interactions and to reflect on my own behaviors to improve. I can more clearly see and reject many ways in which our STEM cultures enact exclusionary macro- and micro- aggressions within and between disciplines as a way to establish hierarchy.

These conversations resulted in a "Rule-of-five" paper which laid out definitions for model and modeling that were inclusive of all our perspectives (Diaz Eaton et al., 2019). Our definition of model allowed us to embrace multiple representations common across calculus, science education, and math education: algebraic, numeric, visual, verbal, and experiential. Our definition of modeling allowed the process of modeling and the process of science to start the process of abstraction and modeling at any of these representations embracing the multiple epistemologies present. This helped us see the commonalities across our work and perspectives so that we could achieve more together, something Gutiérrez refers to as In Lak'ech, derived from Indigenous epistemology, (Gutiérrez, 2017). However, in the Rule-of-Five paper, we used the parable of the blind man and the elephant as an analogy. The blind man touches the leg of the elephant and thinks it is a tree and touches the tail and thinks it is a rope[2]. Each of us alone, with

[2] I prefer In Lak'ech as this analogy strikes me as ableist. It is clear that anyone blind or blindfolded could smell an elephant next to you. However I leave it here to make the connection between the original paper and In Lak'ech.

our own disciplinary perspectives, are discovering something about some context, and together they build broader stories.

The Rule-of-Five framework helped us as biology and science educators understand how mathematical modeling may generate data as a later step, but why data is not seen as a requirement to engage in modeling. The mathematicians also came to appreciate how the field experience and the wet lab were important entry features of the biology modeling experience, which might be better leveraged by mathematics classrooms. Together our differing approaches and epistemologies were part of a broader picture of creating understanding. For example, mathematical models and field or lab-derived data are compared with each other and this is used to refine our mental models. Drawing on the rule-of-five framework to counteract disciplinary microaggressions also helped me personally reconceptualize my own relationship to data as a mathematician.

Our paper (Diaz Eaton et al., 2019) also positioned the Rule-of-five Framework as a way to provide an inclusive scaffold of knowledge and skills for teaching modeling across life science and other disciplines. In the traditions of Yosso's cultural wealth (Yosso, 2005), we hoped to help instructors see and articulate the cultural assets students bring to calculus through their culture and knowledge of their life science disciplines. Instructors could also use the framework to reflect on engaging life students through the comfortable and familiar doors of data and experiential learning. For example, I now contextualized exponential functions in Calculus I by introducing a long-term dataset illustrating rising carbon dioxide levels over time. We could then introduce log-transformation of data and practice linear model fitting.

Discipline (and subdiscipline) is not the only dimension of microaggression, but it is one often surprisingly left out of our discourse on inclusion. Intersectionality is a framework to discuss how race, gender and class identities introduce multiple, intersecting, and potentially multiplicative axes of oppression (Crenshaw, 1991). Applying an intersectionality framework to research in higher education has expanded this lens to additional social identities such as queerness and college identities such as status as a transfer student which refers to students that have earned college credits from other institutions (Harris & Patton, 2018; Leyva & Joseph, 2023). Our use of "disciplinary microaggressions" named how (sub)disciplinary identity, values, and hierarchies might shape experiences in STEM classrooms, STEM departments, and STEM collaborations. With the broader framework of intersectionality added to my mental model, I have been re-examining the same *testimonios* shared above to consider how disciplinary identity interacts with other social identities. My bioinformatics colleague most certainly had experienced a subdisciplinary microaggression, but had also talked about how she was one of the only women

on the tenure-track in her department. Withholding award eligibility for research I had mentored was certainly a disciplinary microaggression to assert the value of experimental science [over mathematical modeling]. But this act has to also be contextualized by the identity of the research student - a woman and a first-generation college student - and her mentor - the only faculty of color in the college, a new assistant professor, and a representation of a broader fundamental change in the value of mathematics in the field of biology.

A common phrase is that "children learn from the actions of their parents." My quest to implement a more inclusive paradigm in my teaching and with my students has been deeply informed not just by working with students over many years, but also by my experiences with other colleagues in academia. I remember talking to a colleague who was a first-generation college student, and she said that you can learn a lot about a faculty member by the way they treat staff members at the college. Likewise, it is hard to imagine how to be inclusive in the classroom if you enact harm between faculty members, at professional conferences, or in the broader community. I work with intentionality to reach across the many borders drawn on our work across disciplinary and social identities and continue to find ways to include instead of exclude. I consciously make the assumption that all people have something to contribute to the intellectual conversation, not regardless of their background and identities, but specifically because of their backgrounds and identities. This is the underlying message of the Rule-of-Five paper, but D'Ignazio and Klein discuss this more thoroughly in their book *Data Feminism:*

> Rather than viewing these positionalities as threats or as influences that might have biased our work, we embraced them as offering a set of valuable perspectives that could frame our work. This is an approach that we would like to see others embrace as well. Each person's intersecting subject positions are unique, and when applied to data science, they can generate creative and wholly new research questions. (D'Ignazio & Klein, 2020, p. 83).

Relationships and care

It is challenging sometimes to give advice to others about how to best collaborate across mathematics and biology, because I see myself as both a mathematician and a biologist. My training throughout my degrees has been interdisciplinary, though my degrees have been in mathematics. But in taking formal coursework from both departments, I was immersed in the culture of each discipline. I was also fortunate to have courses which drew from both disciplines simultaneously. But as I have moved into education research, computer science, data science, and social justice where I have less formal coursework, I have realized how important it is to

read the literature of those disciplines, engage in conversations and collaboration with researchers in those disciplines, and understand their cultural values and norms. Nothing has helped me more in these endeavors than creating and sustaining personal and collaborative relationships beyond disciplinary walls.

It took three years of conversations and idea refinement to finish the Rule-of-Five paper. “Relationships”, more than “collaborations” as a term, implies a deepness in the thought and sharing across positionalities, cultures, identities, and context. One of the reasons why I believe biocalculus reform at Unity was so successful was because Unity students had an extremely strong disciplinary identity related to their major. Many students never switched their majors, and even if they did, the choices all lay within life science and environmental studies.

After working to design calculus for biology, environmental science, and wildlife, I turned my attention to marine biology, because of the relationships I developed with my collaborator while carpooling. She shared feelings of exclusion from the conversation about calculus for biology. I was guilty of this exclusion. I assumed that because I was using examples of modeling fish stock assessment, I was attentive to marine biology. But I learned that freshwater ponds are not salty marine environments, and I worked with her to contextualize the aforementioned carbon dioxide and climate change project against a need to address the health of coral reef ecosystems. It was only through developing relationships that I could see the ways in which I was erasing identity and expertise and find pathways together to new possibilities.

We have invested significant resources into researching “team science” so that STEM practitioners can work with each other across cultural boundaries (Hall et al., 2018). When I began implementing a full day to discuss teamwork organization and practices at the beginning of class-based team projects, my returns were ten-fold. Now, with the interest in open science, I see developing diverse open science [education] communities to share and improve science [education] just as important as developing the cyberinfrastructure to share open science [education]. But developing collaborative communities across cultural spaces is not just a transactional checklist of practices - it is grounded in relationship building.

STEM academic research culture does not always value investment in relationship building. Mathematics, in particular, has a historical perception of solitary genius - but here, I offer counter narratives. A conservation law enforcement professor stopped me once in the hallway, excited to tell me about a class activity using time-of-death tables for animal necropsies. I learned that they were used in poaching cases and now had a new tool to engage students in understanding Newton’s Law of Cooling. The wildlife biology professor with whom I shared many teaching discussions over lunch would reference my calculus class often as a source of

learning population modeling concepts more deeply, which raised my course's credibility and value to students. My teaching and my scholarship have greatly benefited from carpool rides, hallway conversations, and cafeteria lunches.

Fostering community is easier when there is clear value to all participants - a mutual benefit and a shared goal. This conceptualization is likely influenced by my PhD research on the evolution of mutualistic communities. Mutualistic communities, such as plants and pollinators, are diverse and resilient communities. I see a mutualism between the disciplines of mathematics and biology and a mutualism between humans in the disciplines of mathematics and biology. Therefore, the fostering of inclusive and mutualistic communities is a critically important and necessary condition for a resilient and diverse STEM and STEM Education.

Coincidentally or not, reciprocity is the third and final Indigenous epistemological principle that Gutiérrez introduces in Living Mathematx (Gutiérrez, 2017). In this context, reciprocity means caring for each other. Together, Nepantla, reciprocity, and In Lak'ech, are the philosophies that have shaped my work netweaving (Goldstein et al., 2017). I foster communities of learners and leaders, first as the Consortium Director for QUBES (Donovan et al., 2015), with networks funded by the National Science Foundation's Research Coordination Networks for Undergraduate Biology Education (Diaz Eaton et al., 2017), and more recently with the RIOS institute (Diaz Eaton et al., 2022).

However, as much as my netweaving may seem to focus on postsecondary educators, students are a key part of our communities as well. My biocalculus redesign work was at its best when I involved students as collaborators, and I have had many students as curriculum advisors, research assistants, and co-authors. In Lak'ech is a reference to seeing yourself in the person you are greeting and when used as a classroom practice or a research practice with students, it demands that we break down the hierarchies that are part of academic epistemologies (Gutiérrez, 2017). Viewing students as colleagues with their own knowledge to share is a form of "open pedagogy" and creates pathways for students to participate in work that matters to themselves and to each other (Diaz Eaton et al., 2022). I pair that with attention to creating a community of care so that it is clear that we are all working towards the same goals together, supporting each other, and caring for each other's success (Clemens & Robinson, 2021).

When Aikens, Callender Highlander, and I (Aikens, Highlander, & Diaz Eaton, 2021) analyzed open-ended student responses in surveys about our newly revised biocalculus courses across two institutions, we focused on students whose attitudes towards mathematics improved. Students reported more positive attitudes due to realizing mathematics utility-value for life science, due to understanding the mathematics presented, and due to the instructor fostering a positive learning

environment (Aikens, Highlander & Diaz Eaton, 2021). Creating and leveraging relationships that reach across disciplinary boundaries, helps us translate the dialect of mathematics. However, this development of "instructor-student rapport" and mutualistic relationship, where instructors care about the student and their success, is just as important in creating positive relationships with mathematics. Again, we see a nexus where valuing disciplinary cultures intersects with valuing the individual as a human, with relationships at the core of this work.

Humanizing and contextualizing

What we choose to discuss is just as important as what we choose not to discuss.

Dr. Callender Highlander and I had two separate methods for assessing student outcomes in our biocalculus courses in comparison to traditional calculus courses. Each returned a different, but important lesson. At the University of Portland, Dr. Callender Highlander compared three quizzes that the traditional calculus and the biocalculus course both administered (Diaz Eaton & Highlander, 2017). The first quiz was primarily a test of precalculus skills and the traditional calculus students outperformed the students in biocalculus. This finding suggests that biology students had fewer skills in the prerequisite precalculus course, but it could have also reinforced the stereotype that biology students were "worse at math." However, by the third quiz at the end of the course, the biocalculus students outperformed the traditional calculus students. This directly counternarrates the stereotype - biology students are indeed capable of high mathematics achievement, but needed a different kind of experience to realize that achievement.

I used the Calculus Concept Inventory (CCI) to understand learning at Unity College in the biocalculus course as it was revised (Diaz Eaton & Highlander, 2017). This allowed a comparison to outcomes at the University of Michigan which had extensive CCI gain data for its traditional calculus course and was considered a leader in calculus research (Koch & Herrin, 2006). The biocalculus course was doing admirably well, except for I noticed that in two semesters the CCI learning gains crashed. The most significant change: implementing gateway-style examinations like those at the University of Michigan. Students had to achieve a passing grade on each examination in order to pass the course. However, I could tell that my students were extremely stressed, so after these two semesters, I removed them. My students' CCI gains bounced back immediately.

It could be argued that gateway examinations exposed a fundamental difference in how biology students and engineering students best display learning in calculus. However, it may also be important to consider that incoming Michigan students boast a nearly perfect math SAT score and that many students at Unity struggled with disabilities and severe math anxiety. The context

of our educational reform deeply matters when theory meets implementation. Kanim and Cid (Kanim & Cid, 2020) have a paper describing this issue in physics education, with particular attention to whether our research in the United States is appropriately capturing populations that are underrepresented in STEM.

Over the years, I have spent more time making sure curriculum and classroom experiences are crafted with universal design in mind, creating experiences that are accessible and inclusive for students with disabilities without additional accommodation. These students are invisible often until accommodation notices are sent to instructors[3][2], and then we only know to accommodate students who ask. In addition, many of the accommodations we make, such as extra test time, are visible to other students and may be perceived as "unfair" to such students (Deckoff-Jones & Duell, 2018). In many of the classes I teach now, I have replaced exams with projects. Extra time for due dates are easily accommodated as long as they show progress towards their goal. This kind of design illustrates to students that I see them, but they maintain control over who sees their disability or their mental health status. This care-based approach has become even more important in the midst of our mental health crisis in education during the pandemic (Lee et al., 2021).

In juxtaposition to helping maintain invisibility to others, there are also ways that I have intentionally made the invisibilized visible. In class I discuss key figures behind the science we are discussing, explore who they are, and make sure that the readings and research I use in class represent the diversity of mathematicians and scientists I want to nurture. This includes unpacking the racist past of those that are behind the foundations of statistics as I discuss Pearson's correlation coefficient (Quick, 2020). I share my identity as a queer Latina in the United States more because I am often read as part of the hegemony (Busch et al., 2022). The more than 60-year data set on carbon dioxide emissions I had adopted in calculus to contextualized exponential functions came from an observatory on Mauna Loa, a mountain in Hawai'i; This became an opportunity to make visible the long struggle that Native Hawaiians have fought for sovereignty, with more recent news regarding a proposal for a new observatory on the sacred mountain of Mauna Kea (Kahanamoku et al., 2020).

A colleague of mine asked what my classroom "intervention" was in order to propose an educational research experiment. What is it about STEM culture that this humanizing approach is considered an intervention? I do not mean that we have to reject our own culture completely, but rather recognize how our cultures are already shaping academia and STEM in ways that can

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[3][2] In the United States, the Americans with Disabilities Act (www.ada.gov) can be invoked by students to request accommodations which allow equal access to educational opportunities.

exclude people and perspectives that are valuable to our future. Calculus can no longer afford to be a "gatekeeper" (Stinson, 2004). We need to visibilize, value, and center the intersectional disciplinary and social identities of our students and each other so that we can achieve interdisciplinary and inclusive STEM education experiences.

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