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On Linguistics of (Inclusive) STEM Education

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The panel discussion focused on the linguistics of inclusive STEM education under the frameworks of radical feminist theory and indigenous theory and the effects on society of such education. Topics such as inclusive STEM teaching (the role of teachers' positionality, and the role of references made in class), language and storytelling (ways to reframe science communication to educate about climate change), an extractionist relationship to the environment and its impact on STEM teaching, the hierarchy of truth and comparing STEM to non-STEM subjects and questioning this hierarchy, and gendered language–including its influence on teaching and education.

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Introduction

"On Linguistics of (Inclusive) STEM Education" was the second panel to support the co-development of critically representative engagement with the hard sciences. The purpose of this Fiat Lux[1] seminar was to promote critical STEM engagement with the arts and humanities and rethink knowledge production. The panel was held on February 2, 2023, in Eng IV, Shannon Room (#54-134), and centered on the linguistics of inclusive STEM education under the frameworks of radical feminist theory, indigenous theory, and connections to the effects of society on such education. The panelists were Professor Shanna Shaked and Ph.D. candidate Anthony Kim.

Professor Shanna Shaked (she/her) is the Senior Assistant Director of the Center for Education, Innovation, and Learning in the Sciences, working to make STEM courses inclusive.

Anthony Kim (he/him) is a fourth-year graduate student in English studying race, environmental literature, science, technology, and society. His dissertation examines aesthetic representations of vitalism(s) and energy's circulation across boundaries of the self, culture, and environment as represented in works of Black, Indigenous, and Asian diasporic speculative fiction.

Professor Sergio Carbajo (he/him), the moderator and organizer, is an assistant professor at UCLA Electrical and Computer Engineering, an associate professor at UCLA Physics and Astronomy Department, and a visiting professor in Stanford University's Photon Science Division at SLAC National Accelerator Laboratory. He is also currently an equity, diversity, and inclusion officer at UCLA.

Discussion

Research and Interests

Kim - I completed my undergraduate in sociology, focusing on race and human-to-human interactions. I then received my master's in ethnic studies. Having environmental racism conversations with students in STEM expanded my view of race and pushed me to explore the environmental humanities. I decided to expand my research to include thinking about ourselves as organisms within a larger context, world, and politics of energy; deciphering our molecular connection to the environment is crucial to understanding our existence. I discovered the importance of conducting literary analysis in a way where we refocus our camera onto the actors of our world, paying close attention to the place.

Carbajo - You mentioned environmental humanities, can you explain this in the context of cells, humans, and the environment?

Kim - Environmental humanities focuses on humans' place within our environment. Although historically it has been a highly white discipline, Native American and Indigenous comparative frameworks can broaden the field's scope and make it more accessible to all. It is important to shift our mindset from 'we are simply actors going through life' to 'we are shaping our environment just as much as it shapes us.'

Inclusive STEM Teaching

Carbajo - Why does pedagogy need to become inclusive? Shouldn't it already be?

Shaked - STEM teaching is implicitly *not* inclusive, because teaching and institutions were designed for white, able-bodied, Christian men. My parents were higher education professors, so I was born in STEM and academia; I really swam in it. It's important for teachers

to recognize their positionality. STEM is not objective or unbiased. Teachers should recognize that the way they were taught is not the way they should teach. Active learning, having students turn and talk to each other during class, is one way STEM teaching can become more inclusive.

Carbajo - Can we all guess how many ways we can be non-inclusive as students and teachers? How can one be non-inclusive? Perhaps we may exhibit an able-bodied perspective that is adapted for some but not others.

Student 1 - Literature from non-diverse sources, mainly old white men, is non-inclusive.

Student 2 - An environment of competition in classes is too.

Student 3 - Materials that assume background knowledge from certain cultures–like a Spanish class requiring an airplane description, though not all students have been on one.

Student 4 - Access to resources like textbooks is inequitable.

Carbajo - Access to technology is another inhibitor of inclusivity that I'm not sure what to do about. But I appreciated these examples.

Shaked - There are some teachers who, afraid of being non-inclusive, make no cultural references at all. Most teachers make references to things they themselves have experienced, which includes implicit assumptions. For example, if I ask my students to raise their hands if they want to share, I'm assuming all my students can raise their hands. Sometimes I have students use their phones to respond to questions, in an effort to be more inclusive and promote active learning, but one time I had a student who shared with me that they had motor ability challenges that made it difficult for them to use their phone to participate. The fact that they couldn't participate and that they had to come up to me and tell me that, was a burden on the student. Sometimes trying to be inclusive can lead to more exclusion.

Language and Storytelling

Carbajo - I want to turn our focus to language, specifically objective facts, and stories with metaphors for explanations. We often jump to obsessing over the fiction vs. nonfiction distinction. Where does myth start and end? Does it matter so long as we are able to convey the truth about ourselves or the environment? Do you have any commentary about storytelling and how that shapes perspective?

Kim - Storytelling genres must be reframed when looking at society as a whole. When talking about climate change or species extinction, we often do it through a genre of tragedy. The science is all there, and yet we still use these old frameworks. Why is this? We must rethink the science communication we use. It doesn't and shouldn't need to be depressing to talk about climate change. Instead, it is about educating the masses. In Indigenous studies, people often say 'the apocalypse' has already happened, and we survived and managed to repair our relationship with the earth. This is a much more positive perspective that other groups should embrace. Moreover, thinking about Earth as something we have a close relationship with is empowering. In this way, imagination can fuel research and keep us in check to ensure we are protecting our planet.

Extractionist Relationship to the Environment

Carbajo - Our relationship to the environment and engineering often is extractionist. We try to allocate resources with efficiency. This may be the way of storytelling we implicitly adopt in the way we study STEM processes as well as political sySTEMs. In the sense of inclusivity, can we be inclusive within STEM in a way that is not extractionist?

Shaked - Can we be more inclusive in STEM by thinking about the environment in a less extractionist way? In *Braiding Sweetgrass* by Robin Wall Kimmerer,[2] Kimmerer asks a biology professor why two flowers look so beautiful together on a mountain. The professor says the question is not related to biology, but the evolutionary forces that led those complementary plants to grow together involve the pollinators, environment, and other factors. It was a science question, but it wasn't traditional or extractionist.

Carbajo - Academic industrial complex creates marketable products for the workplace. Students are prepared to work in a sySTEM that is very extractionist.

Shaked - What is the purpose of education? To prepare the future STEM workforce. Something I like about the current professor teaching the Food Cluster is that activism is part of the course, integrating science with change. This is one practical approach to changing STEM education.

Hierarchy of Truth

Carbajo - There is a certain assumption of the legitimacy of what you teach when you teach given facts like thermodynamics. Less certain is the legitimacy of storytelling under our frameworks. There exists a hierarchy of legitimacy where facts like Newton's Laws are prioritized. Do you have a take on how this–a tiered hierarchy of what is defined as truth–shapes society or specifically UCLA?

Kim - Often, storytelling or knowledge transferred on South Campus[‡] is used for the markets and does not allow for other rhythms. I think that oak trees and other organisms will sometimes sync up their cycles due to environmental pressures and withhold production for a long time before releasing a huge amount. In terms of storytelling and our environment, sometimes the market does not value these different forms of knowledge thus certain ways of storytelling become silenced. However, in moments of crisis, like climate change, we are forced to revisit these overlooked methods of storytelling. Thus, forms of knowledge that have been marginalized for not being correlated with producing the greatest amount of revenue for a company suddenly become revered.

Carbajo - Any takes on how you implicitly relate to this hierarchy?

Shaked - There is definitely a hierarchy in academia. Hard sciences are considered "more true" than others. There's a physics saying that used to be my favorite: "The plural of *anecdote* is not *data*." It means we should take data on what works with teaching, not just listen to one student's experience. But anecdotes do come from lived experiences, and they can be critical and undervalued when they come from new perspectives. Usually, when I find myself devaluing things, it's because I don't understand them. I try to notice those internal judgments and actively read things that counteract those messages. It's also important to look for when and how those messages are being reinforced.

Gendered Language

Carbajo - I have one last pressing question, traveling back to language, specifically the gendered language of English. How can that gendering shape knowledge that we generate through learning experiences? Are we thinking in gendered forms? Basque is a non-gendered language. I find myself thinking of an object in English and I want to use a gendered pronoun. When gender is absent from the language, I don't find myself applying gender. How does this apply to teaching and our application of gender?

Kim - Firstly, I don't know much about linguistics so I don't want to overgeneralize and say "Language determines our worldview." That said, there was a large anthropological study about shades of colors, tastes, and smells that proved how the frameworks we are given to work with, to comprehend our world, shape what we view as important.[3] Another study of Western vs Indigenous youths examined differences in the cultures' childhood books.[4] Environmental humanities help us better comprehend the world and teach us that it is not merely action heroes conquering the world but the context they are in that influences them and others.

Shaked - There's gender in teaching and physics. I remember in my physics classes, many example problems would be about dropping missiles out of planes, which wasn't very interesting to me. When I started taking astronomy, physics described beautiful things from the universe, and I thought, "This kind of physics is cool." Perhaps the missile examples reflect our military-industrial complex, and it's influenced by certain people deciding what's taught. I also notice that, with my kids, every stuffed animal is a "he." It's interesting seeing how dominant gender is, even at an early age.

Open Question Portion - The panel opened up for students to ask questions.

Student 1 - Research often hinges on things that are very profitable. Some people, though, are just interested in things that are not profitable. How can we distinguish between actual interests and what society has shaped us to be interested in?

Shaked - It brings us back to what we think the focus of education is. It should be this question–helping people understand what impact they want to have on themselves and the world. In terms of trying to understand yourself and what drives you, the question is: How do we do that practically? There is a privilege in being able to ask that question because social mobility comes with training and entering the workforce.

Kim - I sometimes feel like a 'bad child of immigrants' because instead of going into a field with huge pay, I went into academia. Within academia, one must strike a balance between research, tenure-track expectations, and opportunities in the larger LA area (often industry ones). One must ask themselves, "What do I really want out of life? Is it aligned with capitalist narratives?." It is important to study the relationship between job satisfaction and burnout. For me, feeling connected to our world reigns paramount and the STEM field allows students to explore, push boundaries, and give back to their communities while still maintaining a stable job.

Shaked - Storytelling, instead of reciting facts, can help deliver messages in a way that doesn't paralyze people with sadness.

Kim - It's important to think about problems, like climate change, through the lens of social media. This includes studying animals that haven't been in the media a lot, and thinking about how climate change affects them. The art of storytelling allows for communication on social media. This prompts viewers to care about animals they usually don't look at. Simply asking constituents to sign a petition so a bill gets to Congress' floor is rarely productive.

Shaked - There's this idea that, if we only get the facts together, everyone will listen. That's what's wrong with the hierarchy of science–it assumes the facts alone will solve the problem. We should think about how the issue affects people, and how we can tell a story.

Student 2 - I've taken a collective behavior class that looks at corporations working to help the environment. For example, by encouraging customers to buy their product by promising donations to cute animals. How can you compete in that industry without proximity to cute animals to adopt? Can niches open up where things that are less marketable become their own fields? Who are companies accountable to in regard to their ethics?

Kim - It's important to think about proximity. Animals on your screen become a part of your everyday life–like a screensaver–which is often a useful technique.

Shaked - When people compete with each other, even for a good cause, there's extractionism embedded in that. Center X[‡‡] has social justice education, teaching statistics in schools. A lot of it is about the mountain lion population. This integrates the issue and makes education more relevant.

Student 3 - Concerning the idea of students as products: UCLA wants us to be in these high-status jobs. Do you see a way of decentralizing capitalist ideologies within teaching? Is that inherent to a university within a capitalist sySTEM?

Shaked - If you're a university in a capitalist system, how do you separate yourself from it? Lack of awareness is a big part of the problem, even through idealism. Getting away from the competition is a potential solution. Introductory STEM classes are fostering more collaboration, and trying to establish more liberatory frameworks. Sending the message *we want you to work together* from the beginning is important. It also takes away the issue of scarcity–like the scarcity of knowledge, or the scarcity of A's. There are no awards for collaborating–most are individual. Maybe creating awards for collaboration is a step in the right direction.

Kim - As someone passionate about the humanities, it's important to remember that the humanities job market is also highly competitive. There is often this myth of the brilliant scholar working in isolation when in reality we are actually all working together. It's crucial to think about accountability to larger communities than yourself. More specifically, we must push ourselves to find ways to reward groups and not just individuals and to maintain relationships of reciprocity where we pull each other up as we rise. I recognize this is a challenge for a student working within this premade sySTEM.

Carbajo - I decided to not follow the traditional path. It can seem daunting to be trapped in a profit-driven sySTEM, but the university isn't isolated. Bell Hooks[5] taught us that education is the path to

emancipation/liberation. Intellectual capital resides within the university system. It is the place to question, challenge, and shape these systems!

Shaked - Bell Hooks came from a segregated school where they taught that education is liberation. When Hooks started attending an integrated school, she found that white teachers weren't teaching liberation, they were teaching math and reading. Hooks wondered, "Why am I learning this?" She thought the professors at Stanford would finally teach about liberation, but they were socially awkward and each taught one subject. We should ask, "How is what I'm learning going to be liberatory for me? How will it affect society?"

Student 4 - I'm taking my first physics class ever. The difference in teaching is vast between art. It is about performance on tests, not interaction with others. Partner-sharing conjoins these two systems of learning. What can physics and art learn from each other and why does that separation exist in the first place?

Shaked - They definitely have things to learn from each other. My favorite physics assignment has students take physics concepts and apply them to a hobby or interest. They work in groups, make an interactive presentation, and teach family or friends about physics through that project. Different groups would learn different things and give feedback. The differences between the arts and sciences come from the "objective truth" approach. Art has more space for discussion. In reality, even within objective truth, there's so much subjectivity.

Kim - I recognize that there have been a lot of shifts recently. However, just because these dominant Western modes of thinking about society have been questioned doesn't mean there is no objective truth. The context we have grown up in affects our perspective. What happens when two forms of knowledge overlap and bleed into one another? It can be messy but also create unexpected alliances. For instance, look to neighboring rural white and Indigenous reservation communities. These two groups often have shared approaches to protecting the land that may differ from what a professor believes is the best strategy.

Conclusions

The linguistics of inclusive STEM education are connected to inclusive STEM teaching, language, storytelling, extractionism and the environment, the hierarchy of truth between STEM and non-STEM subjects, and gendered language. STEM education is inherently not inclusive. Acknowledging one's positionality is a step toward more inclusive teaching. Climate change education should be reframed to be less depressing and more motivating. Indigenous studies provide examples of more positive framing. Education and the workforce often adopt an extractionist point of view. Shifting this perspective may lead to more inclusive education. There is a hierarchy of truth, viewing STEM subjects as "more true" than non-STEM subjects. This hierarchy should be questioned, as both fields of study have things to learn from one another. Gendered language may influence teaching and education. Science education should consider storytelling as a more effective method of communication than reciting facts. Students should ask themselves how what they are learning can be liberatory for them, and how it will affect society. The "objective truth" in STEM often includes subjectivity. Allowing different forms of knowledge to converge can be complicated, but can create unexpected alliances.

Notes and references

‡ At UCLA, this term is used for the division between North ("soft science") and South ("hard science") campus.
‡‡ At UCLA, Center X provides a unique setting where researchers and practitioners collaborate to design and conduct programs that prepare and support K-12 teachers and administrators committed to social justice, instructional excellence, the integration of research and practice, and caring in low-income urban schools.

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