Supporting STEM Identity Development through Asset-Based Positioning

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Supporting STEM Identity Development through Asset-Based Positioning

How can educators utilize asset-based positioning to structure learning environments that promote success for students in STEM spaces while avoiding some common pitfalls?

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Abstract

This report draws on positioning theory as a way to support bi/multilingual students' language and science identities by recognizing their socio-cultural and linguistic differences as assets in their learning. We use this lens to reframe learners' connections to STEM while simultaneously transforming the learning environment.

Keywords

Positioning, STEM, Identity, Equity, Multilingual Learners

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Overview

Inequities continue to persist in STEM (science, technology, engineering, and mathematics) education outcomes among historically marginalized groups. To this end, much research in science education continues to examine this issue in terms of knowledge and skills needed for youth to participate in these fields (Carlone et al., 2011; Madkins & Nasir, 2019). Equity-centered studies show that learning is much more than knowledge and skills; learning also involves issues of power, identity, and privilege (Nasir & Bang, 2012; Philip & Azevedo, 2017). For instance, the National Science Frameworks (2012) conceptualizes science learning as a part of "cultural accomplishment" and defines learning as the process of becoming a full participant in science learning communities (p. 283). Research shows that full participation includes students' access to becoming epistemic agents, that is to shape the knowledge and practice of a science community (Stroupe, 2014). Yet, questions remain, whose cultural and identity repertoires are positioned as legitimate and valuable in learning communities, and how does this influence what epistemic agencies and identities students have access to in learning settings?

To make sense of these questions, we draw on social positioning theory (see Kayumova & Harper, 2020), which examines the process of how academic identities are socially constructed over time through experiences that minoritized students have in various learning settings. In our current research, we draw from a positioning lens to explore how emergent bi/multilingual students (more commonly identified through deficient-centric language as English Language Learners) are positioned in science learning settings, and how it impacts their developing language and science identities.

Research shows that there is an overwhelming emphasis on academic English language development as a prerequisite for STEM learning for bi/multilingual students (Bacon, 2020; Buxton et al., 2015). As a result, teachers often wrongly assume that English language proficiency is the principal mediator of science learning (Kayumova & Buxton, 2021). When educators designate learners' cultural and linguistic backgrounds as a deficit, it not only impedes students' access to robust and equitable STEM (NAP, 2018) but also refutes their "capacity as a knower" (Flicker, 2007, p. 20).

To this end, this study broadly examines the relationship between language and science identity development. More specifically, we present a study based on what Kayumova & Tippins (2021) refers to as "asset-based positioning" and what it means to design learning environments in ways that position diverse cultural, epistemic, and linguistic repertoires as strengths and resources rather than deficits.

Key Lessons

Positioning and recognizing diverse young people's cultural and linguistic assets as strengths and centering pedagogies around self-determination, dignity, and belonging results in increased investment in learning STEM, positive science identity development, and improved overall well-being among the learners (see Kayumova & Tippins, 2021).

Positioning Students As Self-Empowered

Our research shows that positioning (see Table 1) multilingual students as self-empowered and determinant of their own knowledge production encourages them to more readily engage in multiple communicative repertoires (e.g. translanguaging, code-switching, etc.), modes (e.g., gestures, drawing, etc.), and modalities (e.g., creating videos, artifacts, discussing, etc.) to accomplish tasks and express their knowledge. This, in turn, supports their epistemic agencies and identities, their opportunities to shape the knowledge and practice of a science community, and their ability to see themselves as science people.

For example, one of our integrated STEM programs focused on addressing issues concerning environmental sustainability. Multilingual students, from middle schools located in post-industrial, small urban districts, and with Afro Brazilian, Cape Verdean, AfroLatinx, Portuguese, Haitian, and Middle Eastern backgrounds participated in the program. Multilingual students completed a variety of STEM disciplinary practices that culminated in building their own "smart" air filters. Despite students' various linguistic backgrounds, they displayed sophisticated collaboration and communication patterns as they successfully designed and completed their projects. Multilingual students self-adapted by translanguaging, a process that amplifies other modes of communication such as code-switching, gesturing, or drawing, to negotiate different aspects of the project. We observed how these multilingual students interacted collaboratively and utilized a wide range of multimodal communication strategies to (1) navigate scientific disciplinary knowledge, such as bioengineering and environmental science; (2) sharpen skills such as systems thinking and coding, and (3) accomplish the task of designing a "smart" air filter, all without a common lexical footing.

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Throughout this program, we collected and analyzed data which we present here in a chart that provides examples of moments in which social positioning may emerge within a STEM learning environment. We also suggest ways in which teachers can be attuned to those moments and use them as opportunities to highlight and celebrate students' various cultural and linguistic frameworks as assets in the classroom (see Table 1).

Table 1: Asset-Based Positioning in Classrooms

Positioning	Typical & Asset Based Descriptions	Examples: How might this look like in practice
Spatially	Within the typical classroom, spatial positioning happens through the ways we use, occupy, and set up learning spaces, and often displays physical and spatial examples of who in the room is deemed as holding power, having knowledge, and being allowed agency. Classrooms that use asset-based positioning in a spatial manner are organized so there are multiple and various opportunities for collective sense-making and meaning-making with varieties of social, material, everyday cognitive tools. The organization of this space assumes porous roles and relations among students and teachers, and they are intentionally arranged to eschew possible power differentials (e.g., social hierarchies such as race, gender, class, status, etc.).	Space is arranged for group and collaborative work. Such classrooms are organized to have many types of spaces with a variety of social, semiotic, and material tools for collective sense-making, modeling, exchanging ideas, brainstorming, drawing, listening and thinking. Norms of these spaces are set up so that each and every student can feel and experience ownership over the space and materials, as they practice agency within the classroom.
Discursively	Typically within classrooms, discursive positioning happens through various curricular and non-curricular words, stories, narratives, gestures, and discourses: specifically through acts of communication that convey different messages that can exacerbate existing implicit biases, stereotypes, power differentials, social and cultural hierarchies. Classrooms that operate from asset-based positioning perspective are intentional about curricular choices, narratives, voices, and visuals to not only remove and deconstruct messaging which may convey	Having conversations with students where they can share what issues or questions are meaningful to their lives and using those issues or questions to guide scientific investigations or experimentation, thus widening understandings of "who" does science and what science can be. Creating experiences for students to reflect on the narratives of what it means to be a STEM person, in relation to the external messages they receive and internal

	existing social power hierarchies, status differences, and gender dynamics, but also create opportunities to reconstruct new narratives and relations that builds on each individual students' assets.	messages they create. For example, having students draw (or articulate) what a science person looks like and does or having a conversation in order to dismantle narrow notions of being a science person.
Interactively	Typically, STEM classrooms position teachers as the knowledge gatekeepers and direction givers and students as the listeners and direction followers within many classroom interactions. Classrooms that position students as having assets within classroom interactions base view student inquiries, ideas, and questions as valid, scientific, and a driving force of STEM learning.	Creating classroom conversational norms where the teacher or solely students from dominant groups are not doing the majority of the talking and direction giving, but rather everyone has an opportunity to share their voices and ideas, as well as discover and build on their assets in ways that they can lead the direction of the learning.
Relationally	Typically classroom spaces operate within hierarchical power relations, manifested through existing social hierarchies, status differences, and gender dynamics. Classrooms that position students as having relational assets work to dismantle these existing social hierarchies, status differences, and gender dynamics in order for STEM spaces to position students as valuable members of the classroom community as science people.	Celebrating and honoring the voices and ideas of students through creating asset maps or creating opportunities to learn about and discuss each classroom members' unique experiences, languages, cultural practices, as well as other assets they bring to the STEM classroom.

Teachers and Students as Co-Designers of Curriculum

One of the ways in which asset-based positioning can be implemented in the classroom is by situating teachers and students as co-designers of lessons and activities thus involving students in designing the activities and practices, setting objectives, and deciding on the themes of the curriculum more directly (Kayumova & Tippins, 2021). During the program, we set aside time to discuss, reflect, and co-construct the aspects of the asset-based positioning model and integrated STEM curriculum with close to 60–80 students and teachers, who we viewed as critical research partners (Kayumova & Tippins, 2021). This, in turn, increased teachers' ownership and implementation of asset-based positioning and helped us to rethink our assumptions based on feedback we received from students. This approach builds on the assets that students bring into the classroom by giving them an avenue to share those assets with the class and design a

curriculum that honors their skills and knowledge. Co-designing STEM curricula with students also provides a space for teachers to discuss, reflect, and make sense of asset-based positioning with their students (Kayumova & Tippins, 2021). This, in turn, will ensure the ownership and implementation of asset-based positioning and help teachers and students to develop relationships as co-learners and co-designers.

Issues

Our research suggests that drawing from an asset-based positioning framework to design learning environments creates a space in which strong STEM identities can develop and cultivate the kinds of critical thinking skills in students that will contribute to their future as scientists and leaders.

Identity is Fundamental to Learning

Our research shows that academic identities–such as seeing oneself as a science person or perceiving a sense of belonging in the STEM community–are constructed and reconstructed during social interactions in the context of various roles, positions, and discourses available within learning settings. Students bring their social identities (e.g., racial, ethnic, gender, and linguistic) with them to learning spaces, which educators can either honor, recognize, and position as assets, or dismiss, ignore, or invalidate as deficits.

> [T]he activities and tools with which learners engage will shape their understanding of science and who they are in relation to science learning.

Through positioning and repositioning, students negotiate and develop new identities and ideas about disciplinary belonging in relation to the academic settings they occupy. The research we have been conducting (Kayumova & Harper, 2020; Kayumova & Tippins, 2021) highlights the importance of positioning student identities as assets in their learning rather than deficits. Teachers and facilitators need to be aware of the ways in which they create environments that can unintentionally position students in ways that may be harmful to their potential for learning and thriving as STEM people. For example, if STEM classrooms focus solely on the science done by famous white males, students with marginalized or excluded cultures and identities may not be able to see themselves, their work, or their communities' identities as relevant to science. Additionally, when STEM educators position English as the only language through which scientists access and share ideas about STEM, they also then position students with other cultural or linguistic backgrounds as having a deficit. In these ways, social positioning, or the

valued ways of being, knowing, and doing in relation to dominant practices, becomes consequential to the design of learning environments and the kinds of STEM activities, tasks, and tools-in-use students are given access (Hall & Jurow, 2015). Accordingly, the activities and tools with which learners engage will shape their understanding of science and who they are in relation to science learning. Asset-based positioning represents a specific process that allows teachers to examine how identities are ascribed, negotiated, suppressed, or enacted in moment-to-moment interactions and provides a lens to recognize and intervene in situations in which students are being positioned in ways that may inhibit their learning and harm their long-term social and academic identities.

How Do We Disrupt Inequities In Learning Environments?

It has been widely documented that disparities persist in STEM disciplines and are baked into the larger educational system and that educators struggle with strategies on how to disrupt inequities and enact change within learning environments. The work of disrupting inequities is not a simple problem to be solved. Our research suggests that being attuned to teacher pedagogical moves and how teachers position themselves and their students can help to disrupt possible inequities at the micro-levels (see Table 1). We argue that examining student identity development and positioning provides an opportunity to address these inequities and that looking at these concepts is key to understanding how students will flourish and thrive or remain marginalized in a given learning environment. For example, teachers can make intentional moves in pedagogy and curriculum to deconstruct the myths and false perceptions about the racial, cultural, and linguistic identities of the bi/multilingual students. One of the ways this was demonstrated in our work was through including racially and linguistically diverse representations of scientists and engineers in our curriculum and expanding upon notions of STEM participation. At the micro levels, teachers can position multilingual students from various cultural backgrounds as competent knowledge consumers and producers in STEM by centering students' everyday knowledge, linguistic, and cultural repertoires as intellectual resources for learning.

Figure 1. Students Building Air Filters

Questions for the Future

Upon reflection and working alongside multilingual youth and teachers these are some of the questions we would like to consider more in-depth as we continue our work.

- How do various roles, identities, and positions of young people change given different learning environments?
- How do changes in settings influence their long-term trajectories regarding STEM education and career pathways?
- How does positioning shape students' developing and emergent identities?
- How do diverse children/youth get recognized by others as science people?
- What factors can influence diverse children/youth to self-identify as science people?
- How do these processes play themselves out in their educational trajectories as identifications or disidentification with STEM education and discipline?

References

Bacon, C. K. (2020). "It's not really my job": A mixed methods framework for language ideologies, monolingualism, and teaching emergent bilingual learners. *Journal of Teacher Education*, *71*(2), 172–187. https://doi.org/10.1177/0022487118783188

Buxton, C. A., Allexsaht-Snider, M., Kayumova, S., Aghasaleh, R., Choi, Y. J., & Cohen, A. (2015). Teacher agency and professional learning: Rethinking fidelity of implementation as multiplicities of enactment. *Journal of Research in Science Teaching, 52*(4), 489–502. https://doi.org/10.1002/tea.21223

Carlone, H. B., Haun-Frank, J., & Webb, A. (2011). Assessing equity beyond knowledge-and skills-based outcomes: A comparative ethnography of two fourth-grade reform-based science classrooms. *Journal of Research in Science Teaching*, *48*(5), 459–485. https://doi.org/10.1002/tea.20413

Hall, R., & Jurow, A. S. (2015). Changing concepts in activity: Descriptive and design studies of consequential learning in conceptual practices. *Educational Psychologist*, *50*(3), 173–189. https://doi.org/10.1080/00461520.2015.1075403

Kayumova, S., & Buxton, C. (2021). Teacher subjectivities and multiplicities of enactment: Agential realism and the case of science teacher learning and practice with multilingual Latinx students. *Professional Development in Education*, *47*(2–3), 463–477. https://doi.org/10.1080/19415257.2021.1879225

Kayumova, S., & Harper, A. (2020). Towards onto-epistemic justice: Making identities and agencies of bilingual/multilingual learners visible in science education. In M. Gresalfi, & I. S. Horn,

(Eds.), The interdisciplinarity of the learning sciences, *14th International Conference of the Learning Sciences* (ICLS) 2020, Volume 2 (pp. 909–910). Nashville, Tennessee: International Society of the Learning Sciences. https://repository.isls.org//handle/1/6826

Kayumova, S., & Tippins, D. J. (2021). The quest for sustainable futures: designing transformative learning spaces with multilingual Black, Brown, and Latinx young people through critical response-ability. *Cultural Studies of Science Education*, *16*(3), 821–839. https://link.springer.com/article/10.1007/s11422-021-10030-2

Madkins, T., & Nasir, N. I. (2019). Building on students' cultural practices in STEM. In I. M. García-Sánchez & M. F. Orellana, (Eds.), *Language and cultural practices in communities and schools* (pp. 59–75). Routledge.

Nasir, N. I. S., & Bang, M. (2012). Conceptualizing cultural and racialized process in learning. *Human Development*, *55*(5/6), 247–249. https://www.jstor.org/stable/26764628

National Academies of Sciences, Engineering, and Medicine. (2018). *English learners in STEM subjects: Transforming classrooms, schools, and lives*. National Academies Press. https://sites.nationalacademies.org/cs/groups/dbassesite/documents/webpage/dbasse_191011.pdf

Philip, T. M., & Azevedo, F. S. (2017). Everyday science learning and equity: Mapping the contested terrain. *Science Education*, *101*(4), 526–532. https://doi:10.1002/sce.21286

Stroupe, D. (2014). Examining classroom science practice communities: How teachers and students negotiate epistemic agency and learn science-as-practice. *Science Education, 98*(3), 487–516. https://doi.org/10.1002/sce.21112

Resources

Kayumova, S. *STEAM Your Way 2 College*. 2020 STEM For All Video Showcase. https://stemforall2020.videohall.com/presentations/1714

University of Massachusetts, Dartmouth. *STEAM Learning and Identity Research Group*. STEAM Learning and Identity Research Group. https://www.steamidentity.com

Barnes, J. (July 19, 2019). Language is no barrier at UMass Dartmouth STEAM camp. *The Herald News, Fall River, MA*. https://www.heraldnews.com/news/20190719/language-is-no-barrier-at-umass-dartmouth-steam-camp

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