

Transforming and Improving STEM Education for Minoritized Students

Vincent Basile

RISE Scholar, Ph.D.

Daniel Birmingham

RISE Scholar, Ph.D.

Douglas H. Lee

Higher Education Leadership, Ph.D. Student

RISE Report

August 31, 2020



COLORADO STATE UNIVERSITY



SCHOOL OF EDUCATION
COLORADO STATE UNIVERSITY

The push to maintain high levels of growth and global competitiveness in research and development in the United States continues an emphasis on supporting and extending science, technology, engineering, and math (STEM) education for K-12 (President's Council of Advisors on Science and Technology, 2010) and higher education (National Science Foundation, 2020). While this push has increased interest in STEM education, multiple gaps continue to persist in STEM education that disproportionately impacts youth from minoritized communities, specifically with regards to Black and Latinx students. Federal policy reports have advocated for STEM education improvements; however, these reports also portray minoritized communities in deficit-laden language and make broad generalizations on how to address real needs that can make policy and classroom practices more equitable.

STEM educators can strengthen instruction by understanding and incorporating pedagogical practices that confront systemic inequalities creating disparities in STEM education for minoritized communities. Barriers that have long prevented Black and Latinx communities from engaging fully with STEM in higher education have to be broken down and reimaged.

In this policy brief, the Race and Intersectional Studies in Educational Equity (RISE) Center at Colorado State University highlights research from RISE scholars, Dr. Vincent Basile and Dr. Danny Birmingham. Their research spotlights strategies to expand STEM education for minoritized communities. They point out the need to reframe federal policy



analyses away from a deficit lens, which places blame for racial gaps in STEM education on minoritized youth. They call for transformative pedagogical practices that emphasize consequential learning and the decriminalization of classrooms and schools to address the gaps in STEM. Finally, they call for a reimagination of higher education to make STEM education a right. Throughout, they offer tangible and actionable recommendations.

Reframe Problematic and Oppressive STEM Policy Reports to Increase Equitable Education

National policy reports are used by key decision makers and vested parties to advance varied agenda, so understanding how Students of Color and other minoritized groups are treated serves as a way to understand how these groups are portrayed (Spillane, 2008). In an analysis of different federal education policy briefs with focus on addressing issues of equity for Students of Color in STEM, Basile and Lopez (2015) found a disturbing trend of racial essentializing and racial commodification in the reports. First, policy reports often frame racially minoritized groups using color-evasive or broad language, such as minority/ies and underrepresented, that groups all minoritized groups (Peoples of Color, women, low socioeconomic backgrounds, and those with disabilities), that erases their unique and shared experiences that impact these groups with regards to STEM education and perpetuate deficit narratives. Meaningful interventions meant to address specific minoritized groups could be left out due to a misunderstanding of who

actually counts as minoritized or underrepresented. Also, through interaction with these terms, policy makers are influenced by reproducing “static deficit narratives” (Basile & Lopez, 2015, pp. 533).

Basile and Lopez (2015) found policy reports often used language that portray “Students of Color as a collective form of property and resource held in reserve to serve the economic benefit of those who own the STEM enterprise” (p. 535). Policy reports that called for an increase of Students of Color in STEM fields often did so using justifications oriented solely on commodifying ways in which those students could work for the economic benefit of government and private industry. Even demographic changes in the U.S. were framed negatively as a decrease in percentage of Whites versus positively as an increase in People of Color. By framing STEM education in these ways, policy reports including those studied by Basile and Lopez (2015) that use exploitive and deficit reasoning influences state and nationwide policymakers towards a color-evasive approach to STEM education that needs a more nuanced look. The problematic framing of these policy reports move STEM education and policy away from culturally appropriate and moral practices.

To effectively address STEM education gaps, policy analyses and reports must recognize and offer critical insights into how racial inequalities are systemically (re) produced, and to provide pragmatic approaches to disrupt, dismantle, and counter these systemic inequalities.



Transform Teaching and Classroom Practices to Uplift STEM Education

While federal reports push for the need to advance and fund STEM education, pedagogical approaches and classroom practices are both critical to improving STEM education. In this section, we discuss the impacts of consequential learning (i.e., sharing authority between teacher and students regarding what/whose knowledge is legitimate, and how and where STEM matters) and decriminalizing the classroom. Both can have profound impacts for improving STEM education for marginalized students.

Making STEM matter: Community-engaged teaching and learning. Consequential learning seeks to alter power dynamics and challenge institutional practices in ways that not only recognize but also legitimize students' existing expertise, experience and culture in connection with learning and participating in STEM. Through connecting STEM education to the people and communities they care about, STEM can be seen as potentially consequential to students' current and future lives. Birmingham, et al. (2017) found that when engaging middle school girls with science and a commitment to their community, consequential learning can transform the ways in which youth participate in science and how they its potential relevance to their current and future lives.

While this study focused on middle school girls' experience in science, efforts to contextualize STEM learning through student voice/experience has also been found to benefit teachers. This conception of consequential learning seeks to impact teachers' sense of what participating with STEM for students means and looks like, who and what



is recognized as valuable, and what gets counted as learning. Birmingham, Smetana, and Coleman (2017) found that incorporating an ecological perspective to teacher education can help build what learning looks like for their work with students. Additionally, Barton, Tan, and Birmingham (2020) used the idea of consequential learning to rethink high impact practices in ways that focus on justice-oriented teaching. This paper outlines specific instructional practices that teachers implemented into their classrooms in efforts to make STEM learning more equitable. Some of these include framing student experience and communities as assets, providing space and activity for students to contextualize STEM to issues of phenomenon present in local community, involve action taking in the learning process and engage community members in local science science-related issues through youth-designed, youth-led experiences. This work holds promise to directly impact the experiences of youth of color in STEM classrooms through the incorporation of their voice and assisting teachers in reimagining teaching and learning STEM.

Decriminalize classrooms and schools. Myriad research has found that criminalizing practices in the classroom and in schools significantly contribute to the school-to-prison pipeline for Black and Latino boys. Basile (2020) and Basile and Lopez (2018) found that teachers who engaged in decriminalizing practices can create a profound impact on disrupting the criminalization. Derived from a multi-site, mixed methods longitudinal study, decriminalizing practices include the following:



1. *Structural and procedural.* Making changes to rules and the physical environment which reduce or remove the opportunities or impetus for criminalization to occur. For example, setting up a classroom small group activity such that as students enter, they may immediately begin interacting with items at their tables without having to wait or sit down. This removes the need to demand silence for instructions
2. *Honoring space.* Providing and allowing boys of color the use of physical space to engage in acts of resistance which do not disrupt or endanger themselves or others nor destroy things of value in the classroom. For example, allowing a student to walk back and forth (seemingly without a purpose) in unused space in the classroom during a small group activity.
3. *Assuming brilliance.* Beginning an interaction with a boy of color assuming what he has already done or said, and what he is about to say and do are brilliant and intelligent. For example, a teacher coming to a science table and seeing a large rock broken into tiny pieces in front of a boy of color and assuming the boy just simulated erosion.
4. *Highly respectful interactions.* Interacting with boys of color using language and tone intended to convey an authentic ethic of care, and to purposefully humanize the boys as active participants, with agency, in those interactions. For example, a staff member taking time to thoughtfully explain the reasoning

behind a classroom procedure or rule.

5. *Positive reframing.* Using language and actions to change negative occurrences or moments with expected punishments into positive ones. For example, celebrating the engineering intensity of a boy of color who just broke a carving tool from pressing too hard as a valuable and wanted trait.
6. *Repair.* Purposefully engaging in any or all of the practices listed above after recognizing that criminalization has taken place – the criminalization could come from another adult, systemic practices, or from the same adult engaging in the Repair. For example, apologizing and naming the resource disparities which led an adult to aggressively interrogate a boy of color for using a sheet of construct paper from the closet to complete an engineering project.

Basile elaborated on these practices in his 2020 TEDx talk: www.ted.com/talks/vincent_basile_decriminalizing_our_elementary_school_boys_of_color

Reimagine STEM in Higher Education through Culturally Competent Practices

In higher education, structural barriers also bear negative impacts on the experiences of Black and Latinx students. Black and Latinx students have expressed that large class sizes, a culture of hyper-competition, and invisibility can hinder their sense of belonging and success in STEM fields (Basile & Black, 2019; Lopez, Basile, Landa-Posas, Ortega, & Ramirez, 2019). Basile and Black (2019) also suggest that traditional academic



advising may leave Black students feeling as nothing more than a diversity case and essentialize their academic and career aspirations to stereotypes.

Recommendations from these studies show that STEM education at predominantly white institutions (PWIs) needs fundamental reimaging to ensure successful outcomes. While some Black students have been able to cope by finding alternative, informal advisors, STEM education can adapt mentoring models with vertical support and horizontal support that can include high school students, STEM teachers of color, and practitioners of color.

Lopez, Basile, Landa-Posas, Ortega, and Rameriz (2019) explored Latinx undergraduates' sense of familismo with science and engineering. Familismo, or the sense of a strong identification to collectivism with nuclear and extended family through values such as loyalty, responsibility, solidarity, and reciprocity, had been shown by Latinx. With some aspects of STEM education perpetuating a hyper-competitive nature and reinforcing individualism through large class size and professor-pupil interactions can be reasons why some Latinx students feel that STEM education may not be for them.

Some ways to increase Latinx participation in STEM is to better support spaces that encourage Latinx engagement, like the Society of Hispanic Professional Engineers (SHPE). Instructors should also alter assignments, grading practices, and classroom culture to disrupt a counter-productive culture of competition. Academic support programs can also better leverage Latinx students' cultural values to improve their sense of belonging and academic performance.



Summary of Recommendations

This brief highlights the work of two RISE scholars in addressing systemic injustices and reimagining participation and learning in STEM classrooms. The issues their research draw attention to and challenge are pervasive ranging from national/statewide policy frameworks to pedagogical practices implemented in K-12 classrooms/ contexts and higher education. Their work reminds us that transforming STEM education must be an inclusive and collaborative effort by calling attention to and requiring the involvement of minoritized communities in naming and addressing issues in STEM education, as well as challenging K-12 and university professionals to interrogate their own practices and its impact on minoritized students.



References

- Basile, V. (2020). Decriminalizing practices: Disrupting punitive-based racial oppression of boys of color in elementary school classrooms. *International Journal of Qualitative Studies in Education*, 1-15. DOI: 10.1080/09518398.2020.1747661
- Basile, V., & Black, R. (2019). They hated me till I was one of the “good ones”: Toward Understanding and Disrupting the Differential Racialization. *The Journal of Negro Education*, 88(3), 379–390.
- Basile, V., & Lopez, E. (2015). And Still I See No Changes: Enduring Views of Students of Color in Science and Mathematics Education Policy Reports. *Science Education*, 99(3), 519–548. <https://doi.org/10.1002/sce.21156>
- Basile, V., & Lopez, E. J. (2018). Assuming brilliance: A decriminalizing approach to educating African American and Latino boys in elementary school stem settings. *Journal of Women and Minorities in Science and Engineering*, 24(4), 361–380. <https://doi.org/10.1615/JWomenMinorScienEng.2018020378>
- Birmingham, D., Calabrese Barton, A., McDaniel, A., Jones, J., Turner, C., & Rogers, A. (2017). “But the science we do here matters”: Youth-authored cases of consequential learning. *Science Education*, 101(5), 818–844. <https://doi.org/10.1002/sce.21293>

- Birmingham, D., Smetana, L., & Coleman, E. (2019). “From the Beginning, I Felt Empowered”: Incorporating an Ecological Approach to Learning in Elementary Science Teacher Education. *Research in Science Education*, 49(6), 1493–1521. <https://doi.org/10.1007/s11165-017-9664-9>
- Calabrese Barton, A., Tan, E., & Birmingham, D. J. (2020). Rethinking High-Leverage Practices in Justice-Oriented Ways. *Journal of Teacher Education*. <https://doi.org/10.1177/0022487119900209>
- López, E. J., Basile, V., Landa-Posas, M., Ortega, K., & Ramirez, A. (2019). Latinx students’ sense of familismo in undergraduate science and engineering. *Review of Higher Education*, 43(1), 85–111. <https://doi.org/10.1353/rhe.2019.0091>
- President’s Council of Advisors on Science and Technology. (2010). Prepare and Inspire: K–12 Education in Science, Technology, Engineering, and Math (STEM) for America’s Future: Executive Report. Executive Office of the President, President’s Council of Advisors on Science and Technology.
- Spillane, J. P. (2008). Policy, politics, and the National Mathematics Advisory Panel Report: Topology, functions, and limits. *Educational Researcher*, 37(9), 638–644.

Dr. Birmingham's research examines potential avenues to bridge community and school experiences in order to alter modes participation in STEM and support transformative learning for youth from traditionally marginalized communities. A central aspect of his research is focused on the design of collaborative forms of qualitative research necessary for expanding dialog on the enduring challenges we face in the areas of educational equity and opportunity in STEM education.

<https://apps.chhs.colostate.edu/directoryapi/api/users/getcv/2256/>

In his research, Dr. Basile has critically examined federal STEM education policy briefs spanning two decades, revealing cyclical patterns of racial commodification, racial essentialism, and differential racialization. He has written about the theoretical arguments for increasing the number of STEM teachers of color in K-12 learning environments. Dr. Basile's most recent research examined criminalization of boys of color in after-school STEM settings, and the ways that decriminalizing practices work to disrupt escalating cycles of punishment, control, and resistance.



Ecological perspective

- Consequential learning (<https://onlinelibrary.wiley.com/doi/abs/10.1002/sce.21293>)

Teaching pedagogy

- Decriminalizing
- Assuming brilliance (concrete examples of assuming brilliance, along with suggestions for ways in which educators, teacher preparation programs, and future research may take up this decriminalizing classroom practice)
- Familiso (<https://muse.jhu.edu/article/733636>)

How to make STEM education more equitable and accessible

Outline:

Ecological Connections / connection to community to STEM

- <https://www.nsta.org/connected-science-learning/connected-science-learning-january-march-2018-0/i-never-thought-science>
- <https://onlinelibrary.wiley.com/doi/abs/10.1002/sce.21293>

Assuming brilliance

- <http://www.dl.begellhouse.com/journals/00551c876cc2f027,024da55e7e21d2ce,62b5141d2826d86b.html>

Justice oriented High Leverage Practices (HLP)

- <https://journals.sagepub.com/doi/10.1177/0022487119900209>
- <https://muse.jhu.edu/article/733636>

