

Disrupting the Status Quo: Using -Ships to Assist Student Navigation of STEM Pathways

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DOI hyperlink: <https://doi.org/10.38126/JSPG220103>

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Keywords: STEM; pathways; partnerships; underrepresented; workforce; redesign

Executive Summary: This article invokes a maritime call to educators and STEM community members, communicating the urgent need for metaphorical waterways as pathways for young people to navigate various -ships (apprenticeships, internships, mentorship, and partnerships) to improve access to future careers in STEM. We call on all education and community members to embrace the concept of inclusive and accessible pathways rather than a restrictive pipeline mindset in designing STEM education, mentorship, and apprenticeship programs. Educators, researchers, policymakers, and STEM community partners can embed experiential learning opportunities inside and outside the classroom through career exploration apprenticeships and internships. The authors offer recommendations for school, industry, and organizational partnerships to maximize student success further and prepare them for STEM careers. Educators and STEM community members can collectively leverage resources designed for students to align the classroom curriculum with high-demand skills and long-term job-producing trajectories. Advancing policies to explore STEM in mutually beneficial and culturally relevant ways for current and future educators acts as a tributary that feeds into a larger river. Exemplifying STEM pathways, the confluence of -ships are intentionally redesigned to advance and support STEM interests for learners underrepresented in STEM.

I. Introduction

In the 1965 State of Connecticut Address Symposium on equal education, William J. Sanders highlighted barriers to employment for African Americans. He suggested that the workforce development of African Americans should be the responsibility of industry and the educational system: "It is the duty of placement officers in colleges and high schools to work with employers and unions to get qualified graduates into positions equal to their ability and training." This idea of "qualified graduates" is a particularly tall order in the STEM field. Disparities in science, technology, engineering, and mathematics (STEM) education are

substantial. In 2017, Black, Latine, and Indigenous individuals comprised 30% of the U.S. population and 34% of STEM-intending incoming college students, yet were merely 18% of undergraduate STEM degree recipients (Hatfield, Brown and Topaz 2022). The significant difference in STEM-intending compared to STEM degree recipients signals pressing concerns around this disparity. The support of students interested in STEM must be the collective effort of education and industry. Relying on academics and the sole expertise of counselors or college admissions personnel is insufficient, especially with the inequities and disparities that exist both in college admission requirements and the

PK-12 system, such as course offerings, counselor capacity, and social capital. The intersection of economic status and the reliance on funding tied to academic requirements pose additional barriers for Black, Indigenous, and Latine students pursuing a STEM degree. As such, there is a need to reimagine and make accessible multiple pathways in STEM education and career development.

STEM careers require education policies and programs to expand consistently. We as educators must be innovative and relentless in our efforts to prepare and support students in navigating a multilayered system of post-secondary choices and directions for their futures. Structural racism acts as an equal and opposite force to these efforts for certain populations of students. When advising Black, Indigenous, and Latine students to enter the STEM workforce, acknowledging barriers to access, unique cultural differences, and the role of representation in STEM is critical and acts as a repulsive force against the seemingly impossible and isolating task of supporting students in a system that is not designed for their success.

According to the 2018 Pew Research Center's analysis of diversity in the STEM workforce, Black, Indigenous, and Latine people remain underrepresented in STEM careers due to intentional systemic exclusion, despite the majority of Americans seeing value in racial and ethnic diversity in the workforce (Funk and Parker 2018). However, instead of ensuring the capacity for building pathways to access advanced STEM coursework, PK-12 schools continue to experience limited systemic and cultural changes in school structure. Inequitable school policies, such as standardized assessment results, grade level tracking, and biased STEM program selection processes, contribute to barriers and further fuel structural racism. Segregating career and technical education classes from advanced courses aligned to STEM pathways also poses barriers for Black, Indigenous, and Latine students from equitably accessing relevant career-ready STEM experiences. These roadblocks can continue the cycle of marginalizing future generations of STEM professionals. Exploring the concept of diverse STEM pathways reveals the need for policies and practices in education systems to evolve to prepare young people for their futures.

We challenge and inspire educators to consider replicating the natural brilliance of *the pathways of interconnected waterways* in the ever-shifting STEM field (Batchelor et al. 2021). In this article, we shed light on the “navigational ships” (apprenticeships, internships, mentorship, and partnerships) educators can leverage to improve policies and practices that prepare young people for future careers in STEM. While we focus on the impact educators can make in this ever-changing STEM landscape, we also acknowledge that educators are not solely responsible, nor capable, of disrupting the status quo. Systemic change will come about via partnerships among the STEM education ecosystem, including industry partners, community-based organizations, school leaders, and legislators that help teachers support students in navigating the STEM landscape.

II. Waterways as navigational pathways

Waterways are a source of life and provide accessible navigation to essential resources for communities. Unlike a pipeline, with a singular point of entry and exit, waterways provide multiple channels that facilitate movement. These pathways offer more than just access by supporting one another in healthy ways. Multiple pathways create complex intrapersonal ecosystems that rely on interdependent relationships. Relationships between waterways and humanity embody diverse cultural and social values. Connections within and between communities, ecosystem health, transportation, food, and recreation are a few examples of the multi-dimensional roles of waterways that impact and sustain life (Srinivas, 2016). Waterways as navigational pathways are reflected in STEM education as we use our respective positions to dismantle limited and restrictive pipelines.

In the article *Reimagining a STEM Workforce Development as a Braided River*, Batchelor et al. (2021) offers a contemporary alternative perspective to the rigidly structured pipeline approach in STEM by referencing a collection of adaptable paths that accommodate trajectories in STEM. Our understanding of humanity's connection to waterways allows us to conceptualize this free-flowing approach as we consider how education must change to meet the needs of our students.

III. Experiential learning is the captain of all ships

Experiential learning provides career exploration opportunities that combine content-based knowledge with additional career and technical skills through special programs, organizations, or capstone experiences inside and outside the classroom. The strategic balance of connecting classroom learning and real-world experiences personalizes STEM pathways with cultural shifts, thus increasing the accessibility of experiential learning for Black, Indigenous, and Latine learners.

With recent historic windfalls of federal education funding and a focus on workforce development, educators are now uniquely positioned to address significant shortages in the STEM field by preparing students for STEM pathways. In a study with nearly 8,000 participants, Maltese et al. (2014) found that early interest in STEM disciplines significantly contributes to African American students' persistence in the STEM field. The study concluded that individuals who complete STEM degrees have diverse histories that inspire their pursuit of STEM, and varied pathways to STEM proved advantageous to developing their talent and accessing their profession. Creating purpose-driven experiential learning opportunities that include specific connections with cultural and racial representation provides an additional level of sustained interest in STEM careers for underrepresented groups.

Given the increase in virtual experiences during the global pandemic, educators can more easily incorporate cultural shifts by exploring remote and in-person opportunities for student exposure. Educators can learn by listening to and connecting with professionals to support their students. Podcasts and speakers or presentations are easily accessible resources available to educators. Examples of such resources include:

- The [STEMelanated](#) podcast elevates the voices, experiences, and expertise of professionals who identify as people of color while emphasizing “STEM for All” through understanding free-flowing STEM pathways and varying destinations of STEM professionals.
- [The Nifty Fifty](#) is a signature program of the USA Science and Engineering Festival. The program prioritizes the unique needs of

students when requesting inspiring STEM role models to discuss their work and careers directly with students.

- [Blacks in Cyber Security](#) has a mentoring program providing mentorship, networking, and skill development for Black communities interested in cybersecurity.

Utilizing similar programs and creating opportunities for experiential learning can increase interest and expose students to varied STEM careers. Long-term and targeted partnerships can have additional value. For example, cultivating PK-12 partnerships with youth-centered community organizations focused on environmental justice topics using Indigenous Traditional Ecological Knowledge and place-based learning can create more STEM career entry points. These experiences facilitate stronger community partnerships and encourage students to prioritize using STEM to problem-solve in their communities. Programs like these are impactful for all students, and particularly for communities of color, where purpose, collective work, and responsibility are valued.

IV. Leveraging apprenticeships and internships

An apprenticeship is an industry-driven, high-quality career pathway in which employers develop and prepare their future workforce. Apprentices benefit from paid work experience, professional development, and a nationally-recognized credential (Apprenticeship USA 2022). Similarly, an internship is “a form of experiential learning that integrates knowledge and theory learned in the classroom with practical application and skills development in a professional setting” (NACE 2018). Between 2010 and 2020, 63% of youth apprentices identified as white, while Black and Latine youth were less likely than their white peers to participate in apprenticeship programs (Sullivan et al. 2023). The causes of these barriers to programs include exclusionary recruitment strategies that often fail to attract people of color.

Leveraging equitable apprenticeships and internships can give Black, Indigenous, and Latine students early exposure to STEM pathways, spark new interests, and provide skills for success in the future (Rocha 2022). Educators can combine classroom techniques and real-world experiences through apprenticeships and internships.

Partnerships further add value to students' educational experience, maximize student success, and provide foundational knowledge for STEM career readiness. With support from the STEM education community, educators can leverage resources designed for students to align the classroom curriculum with high-demand skills and long-term job-producing trajectories.

Apprenticeship and internship programs can build on educator expertise and further help educators guide students in post-secondary choices and directions. Educators can:

- Use resources to determine how industry competency models integrate into classroom community culture, curricula, and pedagogy. One example explores STEM-related [standards](#) of academic competencies in industry [competency models](#) while being intentional in design to avoid perpetuating [code-switching](#) to fit dominant norms.
- Incorporate career-focused [apprenticeship resources](#) into a general course or advisory lesson plans to support targeted skill development and emphasize related [Social-Emotional and Academic Development](#) priorities.
- Leverage the U.S. Bureau of Labor Statistics resources to incorporate real-world examples in coursework to encourage students to explore STEM careers or use the [teacher's guide](#) to help students plan future opportunities.

Educators interested in systemic level changes may connect with local education or state education agencies to ensure those entities:

- Connect with businesses and networks that provide students with meaningful ways to gain skills that complement academics and the local economy. The [Maryland Business Roundtable for Education](#) is an example of this work in action.
- Consider district-wide internship experiences before graduation, emphasizing varied STEM opportunities.
- Imagine school [schedules](#) that innovatively use class time to create opportunities for student participation in apprenticeships or internships throughout the school day.

Regardless of how educators use apprenticeships or internships, they both serve as avenues that support student college and career readiness. It is imperative for school sites where there are high percentages of uncertified or novice educators.

V. Reimagining the role of mentorships and partnerships

In addition to internships and apprenticeships, mentorships and partnerships support student achievement in the STEM industry. While apprenticeship programs teach youth a skilled trade, mentorship is centered on developing leadership and management skills for both the mentor and the mentee. Mentor/mentee coalitions have produced positive outcomes such as a sense of belonging, self-efficacy, persistence, identity development, and retention for underrepresented groups in STEM education (Wilson et al. 2012; Zaniewski and Reinholz 2016). Customizing mentorship in STEM for underrepresented students to focus more on successfully navigating cultural spaces that are atypical of the dominant norm and less on content mastery has proven to cultivate more ideal mentoring experiences for Black, Indigenous, and Latine students (Griffin et al. 2010; Smith et. 2019).

Mentorship programs and partnerships develop prominent access points for student entry. With strategic planning, educators and school/district leaders can:

- Develop district-wide mentorship programs with community stakeholders centered around student and family needs to support student success. For example, The [Griffin Bow Tie Club](#) teaches young men the 5 Wells of Leadership: Well-Read, Well-Spoken, Well-Traveled, Well-Dressed, and Well-Balanced. The [Elite Ladies](#) prepares young women to become influential leaders, change agents, visionaries, and entrepreneurs that will positively impact their schools and communities.
- Convene a task force of educational stakeholders to establish state and local college readiness [graduate profiles](#). For example, The Profile of the South Carolina Graduate includes a [prototype of competencies](#) to explore and analyze students' growth in each area.

As we think about how we offer support to students for their future, we can also leverage mentorship and partnership programs to sustain educational shifts that develop the education workforce from their local communities. For example:

- The Center for Black Educator Development (CBED), founded by veteran Philadelphia educator Sharif El-Mekki, identifies and cultivates high school and college students for careers in education. CBED offers young people apprenticeships beginning in high school, mentorship during college, and continued sponsorship throughout the first four years of their teaching profession. The goal is to bring 21,000 Black scholars into the teaching profession over the next 12 years. CBED also partners with organizations like the International Society for Technology Education (ISTE), which has its own [STEAM in education initiatives](#).
- [Heights Philadelphia](#) (formally known as Steppingstone Scholars & Philadelphia Futures), led by respected and veteran educational leaders Sean E. Varen, Ed.D and Sara L. Wood, Esq., leverages strategic partnerships uniting area higher education institutions and corporations with The School District of Philadelphia students. From middle school onward, students gain access to academic, workforce, and college support that breaks down barriers to propel economic mobility. The vision of this organization is for all Philadelphia students to graduate high school and achieve economic mobility through college and workforce success. Heights Philadelphia's Inveniam partnership with the University of Pennsylvania School of Engineering and Applied Science (Penn Engineering), is a [STEM Equity and Innovation Lab](#), which provides socioeconomically underserved and underrepresented students from Philadelphia free access to foundational science, technology, engineering, and math (STEM) resources and mentorship.

Addressing ways education must change to prepare students for the future is underway in almost every corner of our nation. Stakeholders, such as mentors and partners, have an integral role in assisting student navigation of STEM pathways. Reimagining

the roles of various stakeholders in the STEM ecosystem without respect to structural racism risks exacerbating or duplicating challenges at a much more integrated level nationwide. The redesign of education must break down silos by intentionally and meaningfully centering equity and including collective roles in the STEM ecosystem that improve educational access and opportunity for Black, Indigenous, and Latine students.

VI. Educators facilitate student navigational capital

Shaby et al. recently (2021) published a case study about three children's application of navigational capital in an urban and under-resourced community. The research centered on the students' STEM interest during their middle and high school years. Through multiple interviews, each learner credited the "availability and accessibility of both in- and out-of-school learning resources related to their interest, and the support they received from significant adults in their lives in terms of social, cultural, and financial capital," (Shaby et al. 2021). Educators have significant roles in many students' lives and, therefore, must acknowledge when they have the opportunities to be critically conscious of how they use their influence to provide access to opportunities. Acknowledgment of the varying capacities, educators can:

- Leverage district resources to provide students with hands-on career and college preparation support, emphasizing STEM pathways. For example, the District of Columbia Public Schools has [lesson plan resources](#) supporting their guide to college and career academies and a personalized [Guide to Graduation, Career, and College](#) that help empower parents with navigational support specific to their students.
- Commit to [being aware of the impact](#) of our lack of awareness and the importance of creating encouraging academic spaces in STEM classrooms.
- Utilize a collective impact approach that requires commitment shared by educators, leaders, families, and community partners. For example, [Striving Together's](#) cradle-to-career strategy works with education stakeholders and the community to dismantle the cycle of inequitable

outcomes by redesigning systems to maximize student opportunity.

VI. Call to action

The imagery of waterways inspires us to resist the notion of exclusive pipelines in STEM education and careers. Fostering the necessary skills to provide guidance and navigational support to diverse STEM careers requires strong, trusting, and reciprocal relationships that center on student success.

Recognizing the presence of structural racism within schooling and workforce education and training systems is integral to leveraging social and navigational capital rather than the cultural capital of dominant groups. Industry leaders, policymakers, school leaders, teachers, and other stakeholders strategize innovative solutions for increasing underrepresented students in STEM fields.

Communities of color manifest their unique community cultural wealth or knowledge, skills, abilities, and contacts that allow students to survive and resist macro and micro-forms of oppression (Yosso 2005).

As a collective, we must take up the challenge to resolve and establish sustainable partnerships between PK-12, colleges, STEM organizations, and federal agencies. Creating equitable course options, college admission policies, and professional development programs can better support the advancement of Black, Indigenous, Latine, and other marginalized learners of all ages. Advancing policies to explore STEM in mutually beneficial and culturally competent ways for current and future educators acts as a tributary feeding into a larger river of STEM pathways, where -ships advance and support interest in STEM.

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Acknowledgements

I thank God for this opportunity, family, the collective genius of Black STEM educators, and culturally responsive professionals for their love, support, and generosity; my students for sharing their cultural wealth and knowledge; and my colleagues for their unapologetic pursuit to expand access to STEM education and career opportunities for Black, Indigenous, Latine communities.

- Dr. Shakiyya Bland

T'eng'gawd for this opportunity to share ideas that will pave the way for more students of color to pursue careers in STEM. Special thanks to my mom, Martha Jefferson, for igniting my love for science early on and my students, who inspire me to develop memorable, culturally relevant STEM learning experiences.

- Chanda Jefferson

Thank you educators for recognizing a mission greater than self and truly seeing our students. I'm grateful for the opportunity to share a topic of many coffee chats with the world. Special thanks to both Carter G. Woodson and Mary McLeod Bethune.

-Ashley Kearney