



Research Perspectives in Urban Education

Mass Appeal: Designing Open Learning STEM Environments to Promote Participation for Black Boys

Abstract

This paper presents a theory for the design of informal STEM spaces, aimed particularly at nurturing STEM engagement, creativity, play, and penalty-free ideation among Black boys. It introduces a framework for the intentional creation of open learning STEM environments that enrich Black boys' experiences within STEM disciplines through cultural STEM mapping. The ILLEST Lab serves as key evidence of effective design implementation, aligning student interests with technical skill enhancement and a sense of belonging in STEM.

Keywords

authentic, cultural, cognitive, youth-centered experiences, engagement, Black males, STEM

How to Cite

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You don't belong here, you should be on a court hooping with your bros.

—My 9th grade science teacher

I am black, not because of a curse, but because my skin has been able to capture all the cosmic effluvia. I am truly a drop of sun under the earth.

—Frantz Fanon, [Black Skin, White Masks](#)

I want to break from tradition by stating that this work is profoundly personal and deeply connected to the topic, contrary to the typical placement of the

researcher's positionality in a paper. The notion that Black boys must prove their worth to gain acceptance, especially in formal educational STEM settings, echoes the insensitive remarks my science teacher once made, highlighting a pervasive and uncomfortable reality. STEM spaces have historically trafficked in anti-blackness toward Black boys (Lee et al., 2020; Mathews et al., 2022). I am a Black male educator in the STEM space, and I know that no Black boy should ever feel like they do not belong. While there are multiple forms of belonging, from personal to community frameworks (Lee & Robbins, 1995), belonging is a key part of building a community. A person feels at home in a community when they identify with the language and practices of that specific community. In different learning domains, learning scientists have also examined the related concept of disciplinary identity—wherein someone feels that they do or do not belong, for example, as a “math person” (Cheryan, 2011), a “science person,” or an “engineer” (Aschbacher et al., 2010). Even those who feel a sense of belonging to a community may not feel welcomed in the community's workspaces (Bang, 2015), yet when you feel like you belong, you are more likely to be driven (Baumeister & Leary, 1995; Brewer & Gardner, 1996; Kitchen et al., 2012; Kumar et al., 2018; Murphy et al., 2020). A lack of acceptance within those spaces can negatively influence the exchange of ideas, discoveries, and cultural practices, depriving the community of some members' voices and perspectives.

This research perspective serves as an earnest call to action to establish open learning STEM (science, technology, engineering, math) environments through the lens of cultural STEM mapping that can afford Black boys the space to engage, ideate without penalty, and learn through failure without repercussions (Coleman & Davis, 2020; Stevens et al., in press; Thevenot, 2022, Wright, 2019). In this work, I underscore the critical need for their inclusion and advocate the creation of informal out-of-school STEM environments that act as a sanctuary that elevates their voices.

It is imperative to acknowledge that the trauma I endured in formal in-school STEM spaces has fueled my own practice of designing out-of-school informal STEM spaces. These are spaces that allow for creative play as a form of resistance, aiming to dismantle the barriers that have historically policed the bodies and minds of Black boys in formal STEM spaces (Edouard, 2023). The framing of play (Barton et al., 2003; Stewart, 2011) allows Black boys to creatively engage and be their authentic selves while having fun and building community, which is vital not only for dismantling historical barriers but also for

preparing Black boys to take their rightful place in the expanding STEM landscape. As the demand for skilled professionals in these areas surges, the cultivation of a diverse talent pool becomes increasingly critical for the future of STEM industries.

With the robust growth of STEM-related industries, there has been increasing demand for STEM jobs in the market (Funk, 2018). According to the U.S. Bureau of Labor Statistics, between May 2009 and May 2015, employment in STEM occupations in the United States grew by 10.5%, or 817,260 jobs, compared with 5.2% net growth in non-STEM occupations (Fayer et al., 2017). Among the 30 fastest-growing occupations, 10 come from STEM-related industries, six of which are computer and mathematical occupations (Bureau of Labor Statistics, 2019). And as of 2015, 93 out of 100 STEM jobs had wages above the national average (Fayer et al., 2017). Unfortunately, everyone cannot equally access the increased job and higher wage opportunities. In STEM job markets, job opportunities are distributed unevenly across gender, race, and ethnicity. Women and minoritized groups remain underrepresented in STEM careers (National Science Foundation, 2017). According to McKinsey's 2018 report on the technology and innovation workspaces, technical roles are predominantly taken by White and Asian men from elite educational institutions (Hunt et al., 2018).

One of the underlying factors for this disparity is the lack of diversity and inclusion in STEM-related recruitment and retention, which impedes Black males from entering STEM fields successfully. According to statistics from the National Science Foundation in 2011, 20% of Black males who entered a four-year college intended to major in STEM, yet they only earned 6% of total bachelor's degrees in STEM the same year. The underrepresentation of minority students is not only in post-secondary education but also in K through 12 STEM arenas. The opportunity gaps between minority students and their nonminority peers continue to hold strong (Bang, 2015; Blumenfeld et al., 2000; Davis & Allen, 2020).

STEM Learning Spaces

In addressing the issue of underrepresentation, it is essential to first comprehend the factors that contribute to the marginalization of Black boys in STEM fields. The design of educational spaces and activities often creates barriers that hinder Black boys from feeling like they belong in those areas (Edouard & Stewart, 2024; Howard & Howard, 2021; Noguera, 2003). In these spaces, they encounter an

environment of formal in-school STEM learning settings, which may foster feelings of frustration and apathy, carrying over into their engagement with out-of-school STEM learning.

The replication of these formal structures in informal settings can inadvertently perpetuate the very barriers these spaces aim to break down, leaving Black boys caught in a cycle of disconnection and disenchantment with STEM (Méndez Pérez et al., 2023). To bridge this gap, we need a transformative approach that reimagines how these environments operate, ensuring they promote inclusivity and engagement rather than act as mere extensions of the classroom. This continuity in design between in-school and informal learning contexts can prevent Black boys from fully engaging and feeling integrated within the STEM community. A clue to both the opportunities and troubles in STEM-designed spaces surfaced in a remark I overheard at a summer out-of-school STEM camp I designed 10 years ago. A young Black male (Daquan) said, “Why does this camp feel like school? When I come here all we do is talk about the same things we do in school. I thought this was going to be different.” I walked over to the young man and asked him to explain more. He replied, “I mean, this place looks like a school. We have the same books, the same lab tools, and volunteers that work at my school. Wasn’t this supposed to be a fun camp? Y’all got me stressed in here! I thought this was supposed to be fun. Y’all just got me up here in school for the next six weeks, man!”

Daquan’s candid feedback highlights a critical issue in the design of informal STEM learning environments: the unintentional replication of the formal educational structure, which can stifle the innovative and exploratory spirit these spaces are meant to foster. Daquan’s remark underscores the importance of distinguishing informal STEM settings from traditional classrooms to captivate and sustain the interest of learners, particularly those who are already disenchanted with conventional educational models. The challenge lies in creating an environment that is both educational and distinctively different from school to reignite the enthusiasm for learning in students like Daquan at the camp.

Daquan’s reflections also exposed an adjacent problem: the participants in these informal STEM settings were not being supported with agency in high-quality out-of-school STEM programs. Positive experiences at out-of-school STEM programs can enhance participation and learning in STEM (Barton et al., 2003). Particularly, activities in informal STEM spaces, such as libraries, museums, after-school

programs, community centers, and maker fairs, have become explosively popular in recent years due to their great potential to increase students' engagement in STEM, cultivate their creative thinking, and develop their STEM interest and identity (Bang & Vossoughi, 2016; Castek et al., 2019). It is critical to point out that informal STEM learning space alone cannot ensure positive student outcomes or learning experiences ([Edouard & Kim, 2017](#)): well-designed learning environments and activities, supported by authentic cultural connections and youth-centered support, are key to fostering real STEM identities.

Discussion from the Literature

Adopting culturally responsive design is an effective way to engage students in meaningful learning in a space. Out-of-school informal STEM learning spaces, as active learning environments (Bean et al., 2015) in which students use an array of learning expertise to shape skills in real-world design applications, have galvanized educators and researchers ([Hira et al., 2014](#)). However, a tension in informal STEM learning space ethos is the neglectful application of foundation-inclusive and culturally relevant principles to help support a diverse population (Edouard & Stewart, 2024; Habig et al., 2020; Vossoughi & Bevan, 2014). Cultural modeling sits at the nexus of design and cultural practices within informal STEM learning. Carol Lee (2003) developed the Cultural Modeling framework for designing learning environments that are culturally responsive by scaffolding students' everyday knowledge for application to their discipline-specific learning in schools. Dr. Lee's framework demands that STEM practitioners—and the environments they design—deliberately prioritize the needs of participants and map out the intersections between disciplinary content and their lived experiences. Cultural modeling advocates the fluid engagement of students in STEM activities and transitional spaces in their communities (Lee, 2003).

When STEM spaces are designed, consideration for elements like posters or the selection and arrangement of furniture often reflects deeper underlying values and biases. These design choices can inadvertently communicate stereotypes or contribute to a sense of belonging, embedding the designer's perspectives and assumptions into the physical environment. This implicit positionality in design suggests that spaces are never neutral; they embody the ideologies and biases of their creators, shaping the experiences of those who inhabit them. As Langdon Winner asserts, physical artifacts (environments) are a reflection of the politics

of the designer, indicating that every design decision carries with it an inherent set of values and biases (Winner, 1980). Research around ambient belonging, which is defined as a feeling of fitting in a given environment and similarity to the people occupying it, addressed these concerns of racially minoritized participants. In the seminal research on gender participation in computer science courses, researchers found that one possibility of stereotyping objects within the spaces reminded female participants that this was a male-dominated field, which dissuaded them from expressing an interest in it (Dasgupta & Asgari, 2004)

This is further supported by Falk and Dierking's (2000) contextual model of learning. Falk and Dierking's qualitative analysis observed students in informal learning environments, particularly museum spaces, and mapped their learning in relation to their movements in a physical space. The data collected included historic space mapping, photography, and thinking aloud, which were used to build historical thinking activities. Over the course of weeks of repeated museum visits, students began to engage more deeply with staff and the learning environment, influenced by the design of exhibitions, especially those exhibits that invited students to add to or redesign the space. This evolving interaction highlights a similar framework of pluriversal design principles, where the design process becomes a collaborative and inclusive journey rather than a unidirectional imposition (Noel et al., 2023). Students found the exhibits that allowed their input, and that had culturally connected contexts, provided them with a voice and space to engage in the museum community.

The contextual model of learning underscores the significance of designing physical settings in a way that centers and empowers students to take charge of their learning journey, highlighting how environmental factors critically influence educational experiences. Transitioning from this educational model to broader design ethics aligns with the Principles for Design Justice, which advocate using design to sustain, heal, and empower communities, and to achieve liberation from exploitative and oppressive systems (Costanza-Chock, 2020). These principles emphasize the importance of centering the voices of those directly impacted by the design outcomes, ensuring that the design process is inclusive and equitable. This research demonstrates how supporting an individual's agency in creating the overall feel of their learning space situates participants at the center of informal STEM engagement.

At the center of this research is examining how spatial designing (Dudek, 2012) and tools for observation (Blikstein, 2013) have been used as a political tool to

dismantle the hegemonic structure of privilege and power (Apple, 1996; Porter et al., 1990; Vossoughi et al., 2016). One critique of design thinking involves the power inequality between designer and subject (Sheffield et al., 2017). As I explore the creation of maker and other creative spaces for STEM education, we need to consider how the various artifacts support or deter students' ability to engage with the process (Jackson, 2021; Winner, 1980). To design relevant and successful informal science and engineering interventions, we need to consider the psychological, aesthetic, and emotional design of these spaces and programs (Page, 2008).

Cultural STEM Mapping as a Foundation for Equity Design

To reexamine Daquan's remarks: "I mean, this place looks like a school. We have the same books, the same lab tools, and volunteers that work at my school. Wasn't this supposed to be a fun camp? Y'all got me stressed in here! I thought this was supposed to be fun. Y'all just got me up here in school for the next six weeks, man!" The research focuses on designing informal learning environments for Black boys, promoting STEM engagement, creativity, play, and risk-free ideation.

To bridge the creation of these informal spaces with the principle of authentic cultural connection, it's important to understand the latter's role. I define cultural STEM mapping as the planned rationalization of a physical infrastructure, curriculum, and community that allows all members the opportunity to exist and engage equitably in a STEM environment. I use this definition to frame the need to ask questions about the role STEM spaces play in shaping learning and engagement experiences for Black males because educational discourse frequently lauds informal STEM learning as innovative and disruptive, yet there's a contradiction at play: These discussions often gloss over the marginalization of minoritized youths within these supposedly enlightened frameworks. In this research, we critically examine the current models of student-centered STEM learning environments and argue that they inherently sideline the voices and experiences of these youths.

Our inquiry unfolds through a design theory practice known as cultural STEM mapping (CSM). This approach is rooted in the lived experiences and cultural

practices of minoritized youths while cultivating cognitive development with sociocultural connections to foster true engagement in informal STEM spaces (Figure 1).

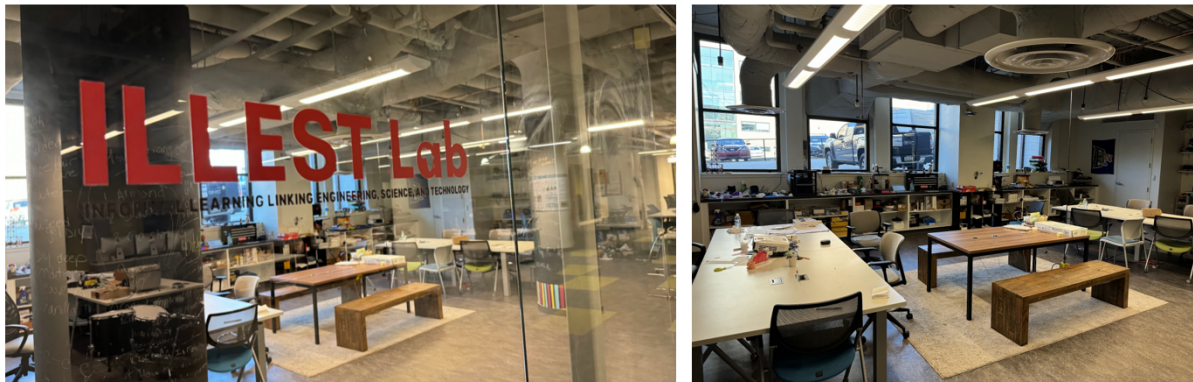


Figure 1. The Informal Out-of-School STEM Space

Note: This figure depicts the ILLEST Lab (Informal Learning Linking Engineering, Science & Technology), an out-of-school STEM space dedicated to fostering playful engagement for Black children.

CSM confronts the monoculture of informal STEM environments, broadening both design approaches and cultural narratives. By empowering Black children to shape their learning experiences (Agency), foster connections with their communities (Community Engagement), promote knowledge exchange across generations (Transgenerational Framework), and align learning with their cultural identities (Youth-Centered Practices), CSM cultivates a multifaceted and inclusive STEM environment. The collective impact of these four themes in CSM not only challenges and reshapes the prevailing singular narrative but also ensures STEM engagement is more accessible, relevant, and empowering for Black youth, addressing the crucial aspects of their cognitive, physical, emotional, and educational experiences.

My application of this approach in designing the ILLEST Lab fundamentally was about bringing external experiences, cultural influences, and youth-centered environments into the lab's physical realm, thereby testing the CSM framework in a real-world setting. This process was integral to bridging theoretical concepts with practical implementation, creating a space where these ideas could be lived

and observed first-hand. This involved meticulously mapping these elements into the space, and maintaining a deep connection with the tools available, such as 3D printers, power tools, virtual-reality headsets, cameras, and lights, all to support a youth-centered narrative of engagement. In the lab, we house 300 pairs of sneakers, tapping into the booming sneaker culture that resonates with and energizes the students. This connection is woven into the fabric of the lab, linking sneaker culture with the technological capabilities of 3D printers and virtual-reality headsets to create unconventional maker projects that fuse students' passion for sneakers with virtual reality, design, and 3D printing. This mapping continues with the integration of both modern and traditional tools, enabling students to construct sustainable and environmentally friendly projects that respond to the community's needs and the ongoing challenges of equitable access to civil infrastructure. Furthermore, the cameras and design stations in the ILLEST Lab facilitate narrative engagement, allowing students to harness social media to narrate their stories and become content creators. Through animation, podcasting, and music, students can produce and distribute content that reflects their experiences and insights. This comprehensive mapping process defines and characterizes the ILLEST Lab as not only a testament to the application of CSM but also as an incubator for computational skills and STEM competencies, supporting the students' journey and pathway into STEM fields (Figure 2).



Figure 2. Design Layout of The ILLEST Lab

Note: ILLEST Lab: student-designed lab with customizable layout and build features, promoting interaction and creativity.

Learners' Cultural Practices

Current discussions in the field of education often laud informal STEM learning environments as innovative and disruptive; however, there is a growing realization that these spaces can inadvertently maintain the status quo by failing to represent and engage the diversity of learners they are meant to serve. CSM stands as a countermeasure to this oversight, foregrounding the lived experiences and cultural practices of minoritized young people. This framework seeks to elevate these experiences, interlacing them with learners' cognitive development, thereby allowing students to see themselves reflected in their educational journey.

By prioritizing the intersection of learners' cognitive growth with their cultural backgrounds, CSM addresses how an intersectional analysis can refine the design of informal STEM learning environments. It asks us to consider: How might we reconceptualize these spaces to better reflect the identities and histories of minoritized students? It urges us to design activities that draw from the cultural wealth of these communities, thereby creating learning experiences that are not only educational but also affirming.

Authentic Engagement

The cornerstone of CSM lies in its ability to foster authentic engagement. This subsection delves into the ways that CSM can be used to design informal STEM spaces that are not merely places of learning but are also communities of practice that resonate with youth (Figure 3). The authentic engagement called for by CSM extends beyond participation: it demands the creation of spaces where young people feel a sense of ownership and belonging.



Figure 3. Design Stations at the ILLEST Lab

Note. The Sneaker Lab is a youth-centered design space that offers design and material science competency learning for students.

This approach necessitates a design that is as much about pedagogy as it is about the environment. It challenges educators to conceive and implement STEM activities that do more than educate; they must inspire, relate, and connect. The research in this section examines the effectiveness of culturally relevant project designs and how they can decrease anxiety and cognitive friction, making STEM fields more approachable and inviting for those who have traditionally been marginalized.

Power Dynamics Analysis

An in-depth exploration of power dynamics forms the third pillar of the CSM framework. This section examines how power and privilege shape the design of informal STEM learning spaces and affect the participation of minoritized young people. It is critical to understand these dynamics to dismantle barriers and create a more equitable learning landscape. The analysis of power within educational spaces encompasses everything from the curricula to the physical design of learning environments, from the selection of resources to the modes of assessment. This section discusses how CSM can serve as a lens to scrutinize and revise existing structures, ensuring that they do not reinforce inequities but rather challenge and transform them.

Inclusive Environment Design

The final subsection of CSM addresses the design of inclusive environments. CSM advocates spaces that not only accommodate but also celebrate the cultural identities of all learners. This means designing environments that are not just physically accessible but also culturally responsive and sensitive. Inclusive environment design requires a thoughtful and intentional approach that appreciates the diversity of the learner population. This part of the research argues for settings that foster comfort and encourage risk-taking, where minoritized students can engage in STEM learning free from the fear of

marginalization or failure. It is in these intentionally designed spaces that young people can harness their cultural strengths to fuel their STEM explorations (Table 1).

Table 1. Cultural STEM Mapping: How Black boys are centered within each theme, and how designers can integrate these considerations into informal STEM spaces

Theme	How Black Boys Are Centered	Design Integration in STEM Spaces
Learners' Cultural Practices	Incorporating narratives and knowledge from Black communities into STEM content.	Using cultural symbols and community references in the design of learning materials and space aesthetics.
Authentic Engagement	Facilitating activities that validate and reflect the interests and cultural heritage of Black boys.	Designing projects that relate to real-world problems in Black communities and invite active contribution from the students.
Power Dynamics Analysis	Actively identifying and challenging systemic barriers that Black boys face in STEM education.	Implementing regular equity audits of the learning content and space to identify and address bias.
Inclusive Environment Design	Ensuring the learning space reflects the cultural diversity of Black boys and promotes their sense of belonging.	Configuring the physical and social environment of STEM spaces to be culturally welcoming and supportive.

Open Learning STEM Environment

Creating environments where Black boys feel safe, free from surveillance on their actions and speech, and where their cultural perspective on STEM is celebrated and integrated, is essential in fostering welcoming and inclusive STEM spaces. Implementing CSM involves action, like using the open learning STEM

framework. This creates spaces where Black boys actively choose where to engage, incorporating their experiences and skills to build a community of practice within these informal STEM environments. The design theory necessitates a direct conversation about how current informal, out-of-school STEM spaces are structured and how they can evolve to better serve marginalized groups.

Open learning STEM environments (OLSE) aim for equity and inclusivity, yet focus on underserved groups like Black boys to enhance engagement, access, and representation in STEM, fostering meaningful change. In OLSE, it's crucial to critically assess the design of spaces—who they serve, the structure of project-based learning and curriculums, and how outcomes are integrated and shared within the community. The OLSE fosters play and creativity while ensuring a safe space for Black boys to be authentic. This authenticity allows them to share personal feelings and build community, inviting others to engage and contribute to a diverse and inclusive informal STEM setting.

The OLSE, pivotal for nurturing inclusivity and fostering engagement among Black boys, rests on four frameworks: Agency, Community Engagement, Transgenerational Framework, and Youth-Centered Practices (Table 2). These frameworks collectively create an educational space where Black boys can thrive by connecting their cultural identity and experiences with STEM learning. In addressing the challenges Black boys face in STEM education, our design of the OLSE is grounded in actively leveraging their prior knowledge and cultural experiences (Figure 4). We regard these elements as assets that enrich both the individual learners and the educational environment they join. Our design strategy integrates the existing knowledge and cultural backgrounds of Black boys to enrich the STEM learning experiences, actively promoting equity and justice within the physical space.

The openness of the OLSE is designed to offer various entry points, enhancing and leveraging the interests of Black boys, including providing timely open access to STEM resources and employing culturally responsive teaching practices. In this OLSE, our goal is to foster a transgenerational learning community, enabling Black boys to interact with educators across different levels of STEM expertise, experiences, and abilities (Edouard, 2023). By establishing a transgenerational community, we not only showcase the diverse progressions within STEM fields but also construct a supportive network that offers clear pathways for the journeys of Black boys in STEM, reducing their anxieties and

aiding in the development of their own STEM identities. This application of design principles in the physical space is a deliberate effort to challenge and address issues of equity, liberation, and justice for Black boys in STEM education.

Transitioning from the broader objectives of the OLSE design, we recognize that individual empowerment is key to transforming these educational spaces. Agency is fundamental in allowing Black boys to take control of their learning experiences. By having the power to influence and direct their engagement within the STEM environment, they develop a sense of ownership and confidence in their abilities. This framework supports the notion that students should have the autonomy to explore, manipulate, and contribute to their learning spaces, leading to a deeper connection with the material and a more personalized educational journey. The active participation that the agency promotes helps in fostering critical thinking and problem-solving skills, essential components of STEM education.

Table 2. Reflections of Black Males on their Experiences in the ILLEST Lab

Theme	Excerpts from Quote
Agency	"I found myself slowly spending more and more time here in the ILLEST lab. It became a safe haven, basecamp, rest stop, a multitude of things for me. However, it was also my creative station, somewhere I could feel free to make just about anything. All I want to do, is create things, and being able to do that in a “professional” setting is amazing to me."
Community Engagement	"Another thing I believe this lab provides is family. Everyone that walks through the doors to the ILLEST becomes a part of this creative family which I think is even more important than anything else. Being comfortable, with the space, and the people in it are crucial in creation, and professional development."
Transgenerational Framework	"We then began a rebuilding process, which helped to elevate the lab to something that I could only dream of. These are three very different forms of creation, but can all

come together to make a giant product."

Youth-Centered Practices

"Whether ranging from music, to art, or even clothing, it was all here for me to create. When the break-in happened, that really hit me in the soul, because it was like a slap in the face of creativity, and my safe space. As I continue to see the work being done here, I feel inspired to create more, and want to push my boundaries to the next level."

Note. This table assigns specific quotes to each of the Open Learning STEM Environment's themes, illustrating how the ILLEST Lab facilitates these principles in action.

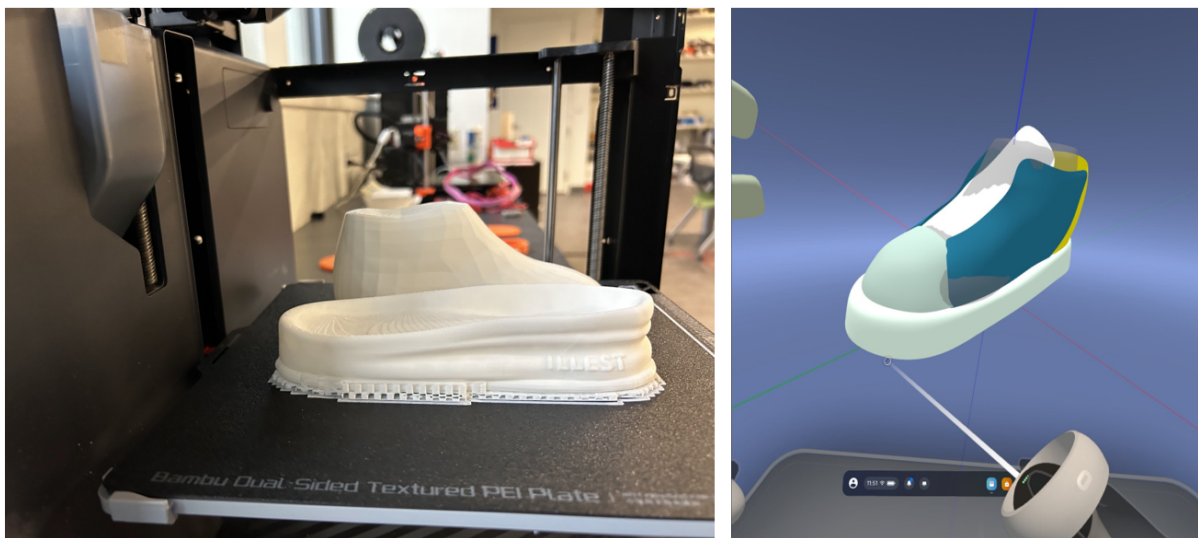


Figure 4. Youth-centered Computational Design

Note. Students use virtual reality and 3D printers to create their own sneakers.

This nurturing of relationships fosters a more interconnected educational experience, bridging generations and fostering a continuum of learning. The transgenerational framework emphasizes knowledge exchange across different age groups and competency levels, which leverages the diverse experiences and wisdom within the community, facilitating mentorship and role modeling for young learners. By connecting Black boys with peers, educators, and professionals across various stages of education and career paths, they gain access to a broader range of insights, inspiration, and support. This

intergenerational learning promotes a sense of continuity and belonging, helping students see the long-term possibilities in their STEM journey and fostering a sustainable community of practice.

Building on this foundation of shared knowledge and communal growth, it’s crucial to develop experiences driven by the core expressions and engagements of the participants. Youth-centered practices prioritize the interests, culture, and lived experiences of Black boys in the design and implementation of STEM activities and curricula. This framework ensures that the educational content is not only accessible but also engaging and meaningful to the students. By integrating elements such as music, art, and community issues into STEM learning, educators can create a more holistic and relatable experience. This approach acknowledges and celebrates the unique perspectives and contributions of Black boys, encouraging creativity and innovation while reinforcing their cultural identity in the STEM fields.

Table 3. Themes of Open Learning STEM Environment in Application

Theme	Structural Implementation	Benefits for Black Boys	Support for Existing Environments	Example of Implementation in Informal STEM Space
Agency	Empower Black boys to modify and interact with the STEM environment, directing their learning.	Gain confidence in influencing their surroundings and owning their educational journey.	Creates a dynamic, adaptable space that fosters innovation and growth.	Sneaker lab: Students design and build their own sneakers, applying their understanding of materials science and engineering.
Community	Involve community members in shaping the	Feel connected to their community	Strengthens ties between the learning	Animation Lab: Hosting workshops where students

Engagement	learning space, reflecting local culture and knowledge.	and see their culture reflected in the STEM space.	environment and the local community.	create animations that reflect their cultural stories and experiences.
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Transgenerational Framework	Facilitate knowledge sharing across age groups for diverse perspectives and mentorship.	Receive mentorship and support, fostering belonging and continuity in STEM education.	Enriches the environment with diverse experiences, promoting lifelong learning.	StoryLab Podcasts: Facilitating podcast creation that allows students to explore and discuss STEM topics with community members.
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Youth-Centered Practices	Incorporate the cultural elements, interests, and experiences of Black boys into activities.	Engage more deeply with STEM through connections to personal interests and cultural background.	Ensures relevant and engaging STEM curriculum, increasing participation.	Textile Design: Implementing projects where students use traditional and modern textile techniques to create culturally relevant designs.
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Note. These examples illustrate how each theme can be practically implemented in an informal STEM learning space, promoting engagement, creativity, and a sense of belonging among Black boys.

Table 3 illustrates how each theme of the OLSE can be practically implemented in an informal STEM space to support and engage Black boys effectively. This engagement is deepened through community involvement in the design process, ensuring that the learning environment is reflective of the students' cultural and social contexts. The transgenerational framework within this model promotes knowledge exchange across different age groups, enhancing the educational experience with diverse insights and mentorship. Moreover, youth-centered practices are fundamental, as they integrate the cultural expressions, interests, and lived experiences of Black boys into the STEM curriculum, fostering an inclusive and resonant atmosphere. Emphasizing equity in this design is crucial to ensure that each aspect of the environment supports the full participation and development of every student, particularly those from historically marginalized groups.

Building on this foundation of individual empowerment, we naturally progress to the broader sphere of interaction and collaboration. Community engagement extends the learning ecosystem beyond the classroom, incorporating the broader community's knowledge and resources. This engagement is crucial for reflecting the cultural and social contexts of Black boys' lives within the STEM curriculum. By involving local experts, families, and community members in the educational process, the learning experience becomes more relevant and enriched, providing students with real-world connections and applications of STEM concepts. Community engagement not only reinforces the curriculum's relevance but also strengthens the bonds between educational institutions and the communities they serve, creating a supportive network that validates and uplifts the students' cultural backgrounds.

Conclusion

This paper presents the theory of designing cultural STEM mapping and establishing an open learning environment for STEM. In this environment, students can choose youth-centered projects, enhancing their confidence and creativity and promoting a sense of play. By integrating these principles, the environment encourages active learning and inclusivity, supporting a shift toward equitable education. The ILLEST Lab exemplifies this design philosophy, demonstrating how aligning with students' interests in a supportive setting enhances technical skills and instills a sense of belonging in STEM. This

approach not only enriches the STEM experience for marginalized groups but also underscores the significance of culturally responsive, interactive, and creative learning spaces.

The commitment to focusing on Black boys, who are notably underserved in STEM, extends the impact of these efforts, advocating inclusivity and support for all marginalized groups within STEM environments. The broader implications of this focus underscore the necessity of comprehensive change, promoting inclusion across the board. Environmental psychology and interior design principles underscore the importance of creating physical spaces that foster a sense of belonging and active engagement, highlighting that effective education transcends curriculum and teaching methodologies to include the physical learning environment itself.

Thus, cultural STEM mapping and open learning STEM environments aim to universally elevate and support marginalized communities, not by isolating interventions for Black boys but by establishing a foundation for equitable access and participation. Through reflecting on personal experiences and prioritizing deliberate design, the objective is to cultivate an accessible, engaging, and empowering STEM environment. This not only nurtures a strong identity in STEM for the most vulnerable but also lays the groundwork for a more inclusive and dynamic educational framework, facilitating creativity, play, and unfettered exploration in informal STEM settings.

References

Apple, M. W. (1996). Power, meaning and identity: Critical sociology of education in the United States. *British Journal of Sociology of Education*, 17(2), 125–144.
<https://doi.org/10.2307/1393085>

Aschbacher, P. R., Li, E., & Roth, E. J. (2010). Is science me? High school students' identities, participation and aspirations in science, engineering, and medicine. *Journal of Research in Science Teaching*, 47(5), 564–582.
<https://doi.org/10.1002/tea.20353>

Bang, M. (2015). Culture, learning, and development and the natural world: The influences of situative perspectives. *Educational Psychologist*, 50(3), 220–233.
<https://doi.org/10.1080/00461520.2015.1075402>

- Bang, M., & Vossoughi, S. (2016). Participatory design research and educational justice: Studying Learning and Relations Within Social Change Making. *Cognition and Instruction* 34(3): 173–193.
<https://doi.org/10.1080/07370008.2016.1181879>
- Barton, A. C., Ermer, J. L., Burkett, T. A., & Osborne M.D. (2003). *Teaching science for social justice*. Teachers College Press.
- Baumeister, R. F., & Leary, M. R. (1995). The need to belong: Desire for interpersonal attachments as a fundamental human motivation. *Psychological Bulletin*, 117(3), 497–529. <http://dx.doi.org/10.1037/0033-2909.117.3.497>
- Bean, V., Farmer, N. M., & Kerr, B. A. (2015). An exploration of women's engagement in makerspaces. *Gifted and Talented International*, 30, 61–67.
<https://doi.org/10.1080/15332276.2015.1137456>
- Blikstein, P. (2013). Digital fabrication and 'making' in education. The democratization of invention. In J. Walter-Herrmann & C. Büching (Eds.), *FabLab*. transcript Verlag. <https://doi.org/10.14361/transcript.9783839423820.203>
- Blumenfeld, P., Fishman, B. J., Krajcik, J., Marx, R. W., & Soloway, E. (2000). Creating usable innovations in systemic reform: Scaling up technology-embedded project-based science in urban schools. *Educational Psychologist*, 35(3), 149–164.
- Brewer, M. B., & Gardner, W. (1996). Who is this "We"? Levels of collective identity and self-representations. *Journal of Personality and Social Psychology*, 71(1), 83–93. <https://doi/10.1037/0022-3514.71.1.83>
- Bureau of Labor Statistics (2019, September 4). *Employment projections 2018-2028* [News release].
https://www.bls.gov/news.release/archives/ecopro_09042019.pdf
- Carey, R. L., Polanco, C., & Blackman, H. (2022). Black adolescent boys' perceived school mattering: From marginalization and selective love to radically affirming relationships. *Journal of Research on Adolescence*, 32(1), 151–169.
<https://doi.org/10.1111/jora.12706>
- Castek, J., Hagerman, M. S., & Woodard, R. (2019). *Principles for Equity-centered Design of STEAM learning-through-making*. <https://circlcenter.org/wp-content/uploads/2019/10/Castek-STEAM-Learning-Making-Whitepaper.pdf>

Cheryan, S. (2011). Understanding the paradox in math-related fields: Why do some gender gaps remain while others do not? *Sex Roles*, 66(3–4), 184–190. <https://doi.org/10.1007/s11199-011-0060-z>

Costanza-Chock, S. (2020). *Design justice: Community-led practices to build the worlds we need*. MIT Press. <https://doi.org/10.7551/mitpress/12255.001.0001>

Dasgupta, N., & Asgari, S. (2004). Seeing is believing: Exposure to counterstereotypic women leaders and its effect on the malleability of automatic gender stereotyping. *Journal of Experimental Social Psychology*, 40(5), 642–658. <https://doi.org/10.1016/j.jesp.2004.02.003>

Davis, J., & Allen, K. M. (2020). *Culturally responsive mentoring and instruction for middle school Black boys in STEM programs*. *Journal of African American Males in Education*, 11(2). <http://journalofafricanamericanmales.com/wp-content/uploads/2020/09/Davis-Allen-2020-Culturally-Responsive-Instruction-for-Black-Boys.pdf>

Dudek, M. (2012). *Architecture of schools: The new learning environments*. Routledge. <https://doi.org/10.4324/9780080499291>

Edouard, K. (2023). Black children at play: The cultural practices of the ILLEST Lab. *Applied Ethics for Instructional Design and Technology*, 77–87. <https://doi.org/10.59668/270.13199>

Edouard, K., & Kim, Y. (2017). *Making culture*. ExCITe Center. <https://drexel.edu/excite/learning/learning-innovation/making-culture-report>

Edouard, K., & Stewart, T. (2024). Show up and show out, young homie: Performative assimilation for Black boys in the face of anti-blackness in informal STEM environments. *Black Educology Mixtape "Journal,"* 2(1). <https://repository.usfca.edu/be/vol2/iss1/13>

Fayer, S., Lacey, A., & Watson, A. (2017). *STEM occupations: Past, present, and future*. Spotlight on Statistics, 1, 1-35. <https://www.bls.gov/spotlight/2017/science-technology-engineering-and-mathematics-stem-occupations-past-present-and-future/home.htm>

Funk, C. (2018, January 9). 1. Diversity in the STEM workforce varies widely across jobs. *Pew Research Center's Social & Demographic Trends Project*. <https://www.pewresearch.org/social-trends/2018/01/09/diversity-in-the-stem->

Habig, B., Gupta, P., Levine, B., & Adams, J. (2020). An informal science education program's impact on STEM major and STEM career outcomes. *Research in Science Education*, 50(3), 1051–1074. <https://doi.org/10.1007/s11165-018-9722-y>

Hira, A., Joslyn, C. H., & Hynes, M. M. (2014). Classroom makerspaces: Identifying the opportunities and challenges. 2014 IEEE Frontiers in Education Conference (FIE) Proceedings, 1–5. <https://doi.org/10.1109/FIE.2014.7044263>

Howard, T. C., & Howard, J. R. (2021). “Radical care” to let Black boys thrive. *Educational Leadership*, 78(6), 22–29. <https://www.ascd.org/el/articles/radical-care-to-let-black-boys-thrive>

Hunt, V., Prince, S., Dixon-Fyle, S., & Yee, L. (2018) *Delivering through diversity*. McKinsey & Company. <https://www.mckinsey.com/capabilities/people-and-organizational-performance/our-insights/delivering-through-diversity#/>

Jackson, A. (2021). Design principles as cultural artifacts: Pedagogical improvisation and the bridging of critical theory and teaching practice. *Mind, Culture, and Activity*, 28(1), 61–81. <https://doi.org/10.1080/10749039.2021.1882500>

Kitchen, P., Williams, A., & Chowhan, J. (2012). Sense of belonging and mental health in Hamilton, Ontario: An intra-urban analysis. *Social Indicators Research*, 108(2), 277-297.

Kumar, R., Zusho, A., & Bondie, R. (2018). Weaving cultural relevance and achievement motivation into inclusive classroom practices. *Review of Educational Research*, 88(1), 31-68. <http://10.1080/00461520.2018.1432361>

Lee, C. D. (2003). Toward a framework for culturally responsive design in multimedia computer environments: Cultural modeling as a case. *Mind, Culture, and Activity*, 10(1), 42–61. https://doi.org/10.1207/S15327884MCA1001_05

Lee, R. M., & Robbins, S. B. (1995). Measuring belongingness: The Social Connectedness and the Social Assurance scales. *Journal of Counseling Psychology*, 42(2), 232–241. <https://doi.org/10.1037/0022-0167.42.2.232>

Lee, M.J., Collins, J.D., Harwood, S.A., et al. (2020). “If you aren’t White, Asian or

Indian, you aren't an engineer": Racial microaggressions in STEM education. *International Journal of STEM Education*, 7, 48. <https://doi.org/10.1186/s40594-020-00241-4>

Mathews, C. J., Robinson, D., & Wilkes, C. E. (2022, November). Cultivating Black liberatory spaces in science, technology, engineering, and mathematics education: What does it take? *Frontiers in Education*, 7, 985455. <https://doi.org/10.3389/feduc.2022.985455>

Méndez Pérez, K., Aguilar, A., Johnson, A., Burgess, C., & Gomez Marchant, C. (2023). Centering humanity within ethnographic research: A critical read of Black boys' lived and everyday experiences in STEM. *Journal of Urban Mathematics Education*, 16, 96–106. <https://doi.org/10.21423/jume-v16i1a476>

Murphy, M. C., Gopalan, M., Carter, E. R., Emerson, K. T., Bottoms, B. L., & Walton, G. M. (2020). A customized belonging intervention improves retention of socially disadvantaged students at a broad-access university. *Journal of Experimental Social Psychology*, 89, 103045. <https://doi.org/10.1126/sciadv.aba4677>

National Science Foundation (2017). *Women, minorities, and persons with disabilities in science and engineering*. National Center for Science and Engineering Statistics, Directorate for Social, Behavioral and Economic Sciences. <https://www.nsf.gov/statistics/2017/nsf17310/static/downloads/nsf17310-digest.pdf>

Noel, L.-A., Ruiz, A., van Amstel, F. M. C., Udoewa, V., Verma, N., Botchway, N. K., Lodaya, A., & Agrawal, S. (2023). Pluriversal futures for design education. *She Ji: The Journal of Design, Economics, and Innovation*, 9(2), 179–196. <https://doi.org/10.1016/j.sheji.2023.04.002>

Noguera, P. A. (2003). The trouble with Black boys: The role and influence of environmental and cultural factors on the academic performance of African American males. *Urban Education*, 38(4). <https://doi.org/10.1177/0042085903038004005>

Page, S. E. (2008). *The difference: How the power of diversity creates better groups, firms, schools, and societies*. Princeton University Press.

Porter, A. C., Archbald, D. A., & Tyree, A. K. (1990). Reforming the curriculum: Will empowerment policies replace control? *Journal of Education Policy*, 5(5), 11–36. <https://doi.org/10.1080/026809390008549063>

Sheffield, R., Koul, R., Blackley, S., & Maynard, N. (2017). Makerspace in STEM for girls: A physical space to develop twenty-first-century skills. *Educational Media International*, 54(2), 148–164. <https://doi.org/10.1080/09523987.2017.1362812>

Stevens, S. Y., Littenberg-Tobias, J., McKneally, R., & Cayko, E. (in press) Designing a curriculum to broaden middle school students' ideas and interest in engineering. <https://par.nsf.gov/biblio/10472469>

Stewart, T. S. (2011). *Culturally responsive physics teaching: Content or conveyance?* [Doctoral dissertation, University of California, Los Angeles]. ProQuest Dissertations and Theses Global. <https://www.proquest.com/openview/0f0151451011284f5e4f78d23cf5a7f1/1?pq-origsite=gscholar&cbl=18750>

Thevenot, Y. (2022). Culturally responsive and sustaining STEM curriculum as a problem-based science approach to supporting student achievement for Black and Latinx students. *Voices in Urban Education*, 50, 60-69. <https://doi.org/10.33682/bhr8-6z56>

Vossoughi, S., & Bevan, B. (2014). Making and tinkering: A review of the literature. National Research Council Committee on Out of School Time STEM: 1-55.

Vossoughi, S., Hooper, P. K., & Escudé, M. (2016). Making through the lens of culture and power: Toward transformative visions for educational equity. *Harvard Educational Review*, 86(2), 206–232. <https://doi.org/10.17763/0017-8055.86.2.206>

Wright, B. L. (2019). Black boys matter: Cultivating their identity, agency, and voice. *Teaching Young Children*, 12(3), 4-7.

Winner, L. (1980). Do artifacts have politics? *Daedalus*, 109(1), 121–136.

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