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Creating a Diverse, Inclusive, and Equitable Learning Environment to Support Children of Color's Early Introductions to STEM

John A. Fuller, Summer Luckey, Rosalie Odean, and Sarah N. Lang
Virtual Lab School, Ohio State University

Science, technology, engineering, and mathematics (STEM) have been a major focus for education reforms over the last decade, including how to support underrepresented minorities' entry into and retention in STEM fields. Using Bronfenbrenner's ecological systems theory as a framework, the current study explored the systematic barriers Black children and children of other marginalized racial groups face in STEM success. STEM learning begins at birth, but most research looking at STEM education begins in kindergarten and beyond. In this article, we review what we know about STEM in early childhood from the microsystem influences of family and school resources to the macrosystem of the educational barriers within broader society. Early childhood educators report being underprepared to support STEM learning and unable to identify STEM learning opportunities for very young children (McClure et al., 2017). An underprepared workforce, as well as a lack of access to high-quality preschool programs, likely contribute to the achievement gap between Black children and White children on math performance at kindergarten entry (Nores & Barnett, 2014). We end our article with a call to action, outlining what we think researchers, policy makers, teachers, and communities need to do to better support young children of color and their STEM learning.

What is the significance of this article for the general public?
To meet the needs of today's society, there is a growing demand for diversity in STEM fields. By supporting children of color, specifically Black and Brown children, and their early introductions to STEM, we can foster a learning environment where all children, regardless of race, socioeconomic status, and ability, can develop a passion for and pursue a STEM education.

Keywords: preschool, equity, inclusion, STEM, children of color

The literature on equity in science, technology, engineering, and math (STEM) addresses a range of issues in our education system. There are disparities in access, opportunity, and success in STEM for racial and ethnic minorities (e.g., Bowman et al., 2018; Estrada et al., 2016; Riegle-Crumb & King, 2010). However, despite the research on K-12 STEM achievement and college persistence, we know little about children's first introductions to STEM. We need to address the STEM achievement gap before it begins by focusing on equity in preschool education. The purpose of this article is to highlight the systematic barriers that actively hinder equity in STEM achievement, specifically for Black and Brown preschool students.

Our article centers on a well-established notion: The experiences of children in their early years, specifically before they enter kindergarten, have a crucial impact on their long-term development and life trajectories (Shonkoff & Phillips, 2000). By offering children of color opportunities to explore STEM-related concepts during early childhood, we can support their confidence in pursuing STEM and lay a solid foundation in STEM knowledge that

John A. Fuller https://orcid.org/0000-0003-1452-3374
Summer Luckey https://orcid.org/0000-0003-2538-1201
Rosalie Odean https://orcid.org/0000-0001-7086-737X
Sarah N. Lang https://orcid.org/0000-0002-6284-7624
Correspondence concerning this article should be addressed to Sarah N. Lang, Virtual Lab School, Ohio State University, 100 Bevis Hall, 1080 Carmack Road, Columbus, OH 43210, United States. Email: lang.279@osu.edu

supports later learning. In this article, we refer to "people/children of color" or "minority" individuals to describe the experiences of Black, Latinx, Native American, and other racial groups collectively. However, we also specifically highlight the experiences of Black and Brown individuals. Looking toward the future, we hope to confront the disparities in fields historically dominated by White men.

The disparities faced by children of color in STEM span many areas of experience and development. Our article draws on Bronfenbrenner's ecological systems theory as a framework for how children's experiences within their families, schools, and communities interact with the larger cultural context to systematically put children of color at a disadvantage for STEM learning (Bronfenbrenner, 1977, 1986). Bronfenbrenner presented nested systems that affect an individual's development: the microsystem that includes those a child interacts with most directly such as family, school, or church communities; the mesosystem that encompasses the interconnectedness of microsystems, including interactions between parents and teachers; the exosystem that includes areas of the community where the child is not directly a member but that might influence the child's experience, such as a parent's workplace or a local school board; and the largest, most remote but encompassing system, the macrosystem, which includes the larger-scale social context in which a child is raised (Bronfenbrenner, 1977). As Bronfenbrenner described in his later work (Bronfenbrenner & Morris, 2006), children are not passive recipients within this model but are active agents whose development is shaped by processes of bidirectional interaction between the child and the contexts in which they are embedded. Indeed, aspects of the child, such as their race, ethnicity, gender, ability status, and previous experiences with STEM, may influence how adults in children's immediate environments engage them in STEM.

The ecological systems theory provides this article with a frame by which we can consider how children influence and are affected by the larger cultural context in which they live, as well as their day-to-day interactions (Bronfenbrenner, 1986; Bronfenbrenner & Morris, 2006). We begin by defining STEM and why having people of color, particularly Black and Brown people, in STEM fields is crucial for society (macrosystem). We present what we know about disparities in STEM education within higher education and K-12 education and how STEM is taught in early childhood in homes, child care centers, and communities (microsystem and mesosystem). Finally, we end this article with a call to action, where we present what researchers, policy makers, and members of our communities can do to support STEM learning for Black and Brown children in early childhood.

What Is STEM?

The acronym STEM has been plastered on news stories (e.g., Angier, 2010), scientific publications (e.g., Stohlmann et al., 2012; Xie et al., 2015), and even schools (e.g., STEM Institute of Early Learning; Early Childhood Learning & Knowledge Center, 2020) over the last decade. The focus on STEM in education, from young children to university students, has been driven by the concern that children living in the United States are falling behind in the sciences and that we must rethink how we teach science, technology, engineering, and mathematics to make these topics relevant to our children and our society (Gonzalez & Kuenzi, 2012). While the topics STEM covers are in the name, there is variability in exactly which fields are included under the STEM umbrella. For example, under the Obama administration's Federal STEM Education Strategic Plan, STEM was defined narrowly, including only "physical and natural sciences, engineering, and mathematics disciplines, topics, or issues" (Committee of STEM Education, 2018, p. 12). Until 2016, the Department of Homeland Security (DHS) used a narrower definition, focusing on chemistry and physics for the sciences (Gonzalez & Kuenzi, 2012). The DHS currently uses a definition including 18 different classifications of instructional program series (DHS, 2016). The National Science Foundation generally considers psychology and other social sciences to fit within STEM; however, for some programs, such as the S-STEM program, more limited disciplines might be included (National Science Foundation, 2020). These discrepancies can make it difficult to understand the needs of the STEM workforce and what factors might lead to success in STEM. For the purposes of this article, we use a broad definition, including physical, biological, and social sciences.

Need for Black Scholars in STEM

As the United States depends on STEM fields for growth, expansion, and upward mobility, there is a call for meeting the demands of an inclusive workforce within the fields of STEM (Brown et al., 2017;

Mondisa, 2018). Galinsky et al. (2015) described how diversity positively influences the growth of societies by effectively navigating obscure challenges and contexts through complex higher-level thinking and processing. Through these developmental stages, diverse groups increase innovation, creativity, economic growth, and quality decision-making throughout their organizations in comparison to their homogenous peers. As larger-scale groups and communities benefit from the interactions of diverse members, STEM-related fields can also benefit from diverse composition as unique perspectives are shared and incorporated between members with varying knowledge and skill sets, which is known to increase work-group performance (Phillips et al., 2004).

Given these benefits, the STEM workforce could further advance from the inclusion of Black scientists, researchers, and practitioners. As racial disparities often infiltrate the health care system, research has found that Black adults who have a Black doctor benefit from higher levels of satisfaction with their health care (LaVeist & Carroll, 2002). Additionally, having a Black doctor was found to lower mortality rates for newborn Black babies (Greenwood et al., 2020). As discrimination, bias, and disruptions in communication due to cultural differences can impact the preventative care that patients receive (Alsan et al., 2018), it is imperative that all STEM fields work to diversify and include Black scholars. Reducing the racial gap within STEM education is one way to effectively support those seeking aid from STEM professionals.

This diversification can only be done by increasing the number of minority students in STEM fields through access and inclusion (Collins, 2018). Currently, Black students are underrepresented in STEM-related undergraduate majors, graduate majors, and careers (Corneille et al., 2020). Diversifying the STEM field with Black scholars is of great benefit to science and its impact on the larger society. For example, Black representation in STEM provides a unique cultural lens to STEM fields that adds value to the fields, benefits the student, and benefits the communities where they live. Collins (2018) examined the factors contributing to Black student STEM identity that influenced student achievement and matriculation within the field. The author's findings indicated specific themes (e.g., lack of reflective identity, lack of effective, cultural curriculum, and development of conflicting identity) that impeded upon Black student STEM identity and achievement; gaps in enrollment and retainment of Black STEM students at all education levels were revealed and could be addressed with Black scholars' insights and perspectives.

Building upon the aforementioned benefits of diversity within groups, not only would the inclusion of racially diverse persons in the development of STEM education bring awareness to the ways in which STEM education covertly excludes minority students, but Black scholars can also serve as a direct line of support or encouragement for students through representation or hands-on mentoring that lessens the racial gap within STEM. Green et al. (2019) noted that Black students who choose to pursue a STEM-related major are often unsupported within their perspective fields, further highlighting the importance of maintaining this body of diverse students within STEM.

Racial Disparities in STEM and Education

Higher Education

Fields with the highest level of social and economic value (e.g., STEM) often have the greatest amount of White privilege and racism (Riegle-Crumb & King, 2010), limiting the advancement of people of color in these fields. Consequently, students of color have to deal with not only their rigorous course work but also the racism, discrimination, prejudice, and microaggressions that prevail in the larger U.S. postsecondary landscape. The macrosystem, or larger cultural elements, in which we are raised (i.e., socioeconomic status, ethnicity, geographic location, etc.) helps to mold the social and economic value that is assigned to a STEM degree (Bronfenbrenner, 1977). The perceptions of success for those working in the STEM field develop from our macrosystem, but it is important to consider who is obtaining such degrees.

Black and Latinx students are as likely as their White peers to enter a STEM major; in particular, students majoring in physical science or engineering are predominantly men, but they are not disproportionately White men (Riegle-Crumb & King, 2010). Indeed, Black men at a 4-year institution are more than 2.5 times as likely to declare a physical science or engineering major than their White counterparts (Riegle-Crumb & King, 2010), but Black students are less likely to persist in their STEM major than White and Asian students (Chang et al., 2014). This finding suggests that not all minoritized students face the same barriers to graduating with a STEM degree. In fact, Chang and Colleagues (2014) operationalized the term "underrepresentation of racial/ethnic minorities" to differentiate the collective experiences of Black, Latinx, and Native Americans from that of their White and Asian American counterparts as these are two racial groups that are not underrepresented in STEM majors or fields. We argue that the aforementioned social and economic value of a STEM degree offers a plausible explanation for the continued enrollment of Black STEM majors; however, there is a demonstrated need for support, resources, and mentorship of Black students in STEM.

Black and Latinx students are more likely to switch from a STEM major, compared with White students, and are more likely to drop out of college before completing a STEM degree. When socioeconomic status and high school academic preparedness are controlled for, completion rates for Latinx and White STEM majors look similar (Riegle-Crumb et al., 2019). However, compared to White and Asian students, Black students continue to face a disadvantage in completing STEM majors (Chang et al., 2014; Riegle-Crumb et al., 2019).

Given the social and economic value of the STEM field, as well as the greater likelihood that Black and Latinx students switch their major away from STEM or to leave college altogether, we argue the phenomenon of opportunity hoarding is at play. Opportunity hoarding is when a group in power controls access to a valued resource and, hence, is advantaged for the present and future (Riegle-Crumb et al., 2019). Riegle-Crumb and Colleagues (2019) argued that White students, faculty, and administration are hoarding the opportunity and success from anyone who is not already benefiting from a career in STEM. In a larger social context, this speaks to the marginalization of students of color in STEM and higher education. With the existence of racism, White privilege, and opportunity hoarding, we must look earlier than college and reflect on how we set up students of color to succeed in STEM. As a result of the systemic bias and racism that exists within the macrosystem, the attitudes students of color have toward STEM, which develop in their microsystem interactions, are impacted.

K-12 Education

In the 2017–2018 school year, nearly 80% of public school teachers were White, while fewer than 7% were Black (National Center for Education Statistics [NCES], 2020). The student body, by contrast, is increasingly made up of non-White students, with White public school students dropping from 61% in 2000 to only 44% in 2017 (NCES, 2020). Most Black children, as well as most Latinx and Native American children, attend schools that are at least 75% non-White (NCES, 2020). These data show the continued segregation of public schools in the United States and the racial discordance between teachers and students. The effects on children are lasting and concerning. Non-Black teachers are more likely to describe Black children's behaviors as disruptive (Wright, 2015) and rate children's academic abilities lower than Black teachers would rate the same children (Gershenson et al., 2016). Additionally, being taught by teachers of color increases graduation rates and college attendance rates for students of color (Carver-Thomas, 2018). Hence, the K-12 workforce has important implications for children of color's overall success but also advancement in STEM.

Underrepresentation has contributed to the trends we see in students of color's STEM achievement (Basile & Lopez, 2015). This discussion is especially important when considering public schools serving predominantly Black students. Underfunding in schools has increased inequities and segregation (Ostrander, 2015). Hanselman and Fiel (2017) concluded that opportunity hoarding can be seen as early as elementary school; White and Asian families seek to maintain their educational privilege by hoarding high-achieving elementary schools, consequently increasing their access to early STEM learning. The lack of funding in public schools serving Black students has a direct impact on STEM; children attending underfunded schools are less likely to have access to STEM tools and technology (Adamson & Darling-Hammond, 2012). This brings up a challenging question about how we can cultivate children of color's motivation and achievement in STEM without a representative workforce or proper funding of such initiatives. The inequities that exist in our macrosystem work to hinder children of color from accessing high-quality STEM education, and hence the most effective changes will aim to address systemic barriers at the macrosystem and exosystem levels.

Understanding STEM in Early Childhood Education

The Importance of the Early Years

The first 5 years of life are an incredibly important foundation in a child's life; the experiences children have in those formative years can set them up for successful trajectories or, conversely, put them at risk for a host of academic, physical and mental health, or social problems as they proceed through formal schooling and adulthood (Shonkoff & Phillips, 2000). Indeed, early childhood is hailed as the most critical time with regard to brain development as a child's interactions, contexts, and experiences influence the very architecture of their brains, forming the neural foundation upon which further learning will rest or build (Shonkoff & Phillips, 2000). Three key microsystems (Bronfenbrenner & Morris, 2006) provide the most immediate influence on young children's development—children's interactions within their homes, their early care and education (ECE) programs, and their communities or neighborhoods are all places that can influence not only their overall or collective development but also, more specifically, their knowledge and skills with regard to STEM (McClure et al., 2017). Below, we first define STEM in the early years; then, we describe the diversity of experiences children have within their homes, ECE programs, and communities.

STEM (STEAM) in the Early Years

While much of the focus of STEM has been on education in kindergarten and beyond, and indeed the definitions given above cover academic fields that are well beyond the experience of young children, the foundations for STEM education begin in early childhood. In the early years, children are learning how the world works, and by giving them the opportunities to explore concepts from science, technology, engineering, and mathematics, they can begin to gain the competence to be STEM learners going forward. In Table 1, we give some examples of what STEM activities might look like for preschool-age children.

In the ECE classroom, we note the importance of STEAM (science, technology, engineering, art, and mathematics). The addition of "art" to STEM embeds the goal to include the liberal and visual arts in children's understanding of STEM, emphasizing creative thinking and problem solving as integral parts of preschool curricula, rather than segmenting children's early learning experiences into nonintersecting disciplines (Aktürk, & Demircan, 2017).

STEM Learning at Home

Parents and other family members play an important role in the STEM experiences young children have. One opportunity to introduce young children to STEM concepts is through media such as STEM TV, computer games, or apps to introduce children to science and math (Sheehan et al., 2018). Sheehan and Colleagues (2018) found that children who have a family member in a STEM career were less likely to engage with STEM media. Additionally, for those children without a STEM career family member, spending more time using STEM media was negatively related to science and math skills. These findings imply some relation between the amount of STEM media usage and STEM learning at home, but it is unclear from this study whether STEM media has a direct impact on science and math skills, either positive or negative, or if the findings represent a latent variable, parental comfort with STEM. Parents who are uncomfortable with STEM may be more likely to offer their children STEM media as an alternative learning approach, rather than discussing the concepts directly. It is worth noting that this study did not control for overall screen time, and it is possible that those children who used more STEM media also spent more time using media overall, potentially reflecting less time spent on other learning

Table 1
Examples of Activities for STEM That Would Be Appropriate for an ECE Classroom

Science	Technology	Engineering	Mathematics
Learning about the scientific method:1. Ask a question2. Gather information3. Form a hypothesis4. Test the hypothesis5. Share the result	Learning about pattern making, the basis for computer coding	Building block towers and structures	Counting how many kids are at school
	Learning *how* technology works—for example, exploring moving the mouse, typing on keys	Making train tracks that can connect in a loop	Counting out lunch—for example, making sure each child gets 1 plate and 5 potatoes

Note. ECE = early care and education.

activities. Studies have found that for young children, excessive use of screen media is correlated with lower cognitive skills and academic achievement (Duch et al., 2013). Additionally, parents may have trouble identifying quality STEM media. Callaghan and Reich (2018) found that most math and literacy apps for preschoolers fail to provide appropriate guidance and feedback to support learning for young children. Perhaps the easiest way that parents can support their children's STEM learning is by using more STEM-related language. The amount of math-related language parents use at home is predictive of children's emerging math skills (Ramani et al., 2015), and similarly, parental use of words describing space predicts children's spatial language use and spatial reasoning skills (Ferrara et al., 2011; Pruden et al., 2011). When considering how to support families in using more STEM language, we suggest considering how to increase opportunities in which STEM language might be naturally elicited, such as measuring during shared cooking, counting pairs of socks, or gazing at the night's sky. Zippert et al. (2019) found that using a math-based tablet game with their preschool-aged child could elicit math talk from parents, even in the absence of any instruction from experimenters. From these studies, we see the importance of interactions in STEM learning at home.

Early Care and Education Contexts; Implications for Early STEM

Most young children in the United States attend some kind of ECE setting outside their home (Haynie, 2019); however, these settings can vary widely from public/private preschool, to child care centers, to Head Start or Early Head Start programs, to licensed family child care homes, or to informal kith and kin networks. The role of ECE professionals, broadly defined, is unique and often underappreciated, though the training of these professionals and the quality of ECE setting is paramount to children's success (Institute of Medicine and National Research Council, 2015; Whitebook et al., 2016). ECE has been neither recognized nor supported as a public good in our country (MacEwan, 2013). Unlike elementary school where all children are guaranteed public education, families in the United States are constrained by what ECE programs they have access to and/or what they can afford. MacEwan (2013) argued that "[preschool] education is the passing on of culture"; furthermore, a high-quality preschool education increases the opportunity for "people [to] both get the most out of and make the greatest contributions to society" (p. 5). Although high-quality early education and care have been associated with positive academic outcomes for students of various populations, this truth is further evident in minority communities. Barnett et al. (2013) stated that there is no other community where ECE is more crucial than the Black community—indeed, high-quality ECE experience serves as a pathway for safeguarding the success and healthy development of Black adults. Teacher-child interactions, rigorous content, and consistent exposure to academic knowledge lay the foundation for education and learning that benefits children (academically and socially), and these elements have the potential to close the opportunity and achievement gaps that are effects of the lack of access to quality ECE (Barnett et al., 2013; Kenly & Klein, 2020; Pianta et al., 2020).

Appropriately supporting early childhood and positive early childhood development is a key factor in maintaining, or rather expanding, U.S. economic growth (Heckman et al., 2010). Evidence has shown that high-quality preschool education has a high economic return as well as social and cognitive gains as children become productive members of society (MacEwan, 2013). Furthermore, the U.S. Department of Education (n.d.) has argued a strong STEM workforce is essential to maintaining the nation's economic prosperity and status as a global leader in science and technology infrastructure. In these interests, strengthening STEM education from the beginning must be prioritized. As emphasized by the National Center on Early Childhood Development, Teaching and Learning (NCECDTL), children naturally engage in STEAM every day; when children play, they are building skills and theories about how the world works (NCECDTL, n.d.). However, without adult scaffolding, children may not learn the language or reflect on the processes, critical within STEM. When adults are well prepared to support early STEM knowledge, they offer critical questions and intentional experiences to teach the value of the process of scientific inquiry such as observation, prediction, and experimentation and the language to compare size or quantity and to consider speed, distance, or measurement in children's interactions with materials (NCECDTL, n.d.). Although children may naturally engage in an exploratory way with materials, and often work with their peers to build, test theories, or solve problems, an ECE teacher's thoughtful engagement can provide critical feedback, vocabulary, and structure to capitalize on children's natural inclinations.

McClure and Colleagues (2017) examined the current state of STEM in ECE, using an ecological lens to understand the barriers to securing and implementing strong early STEM experiences for all children within children's home lives, ECE experiences and immediate communities, as well as public policy and larger cultural beliefs. From their work, it is clear that many parents and ECE professionals are underprepared to support STEM and believe that STEM is for older children and thus may benefit from assistance in seeing how young children's natural behaviors lay the foundation, and open the door, for early STEM learning. McClure and Colleagues (2017) also examined how STEM has been addressed from a curricular perspective in ECE. Although there have been some successful curriculum interventions targeting specific subjects—for example, mathematics (Clements & Sarama, 2008)—there does not appear to be a comprehensive ECE curriculum that targets all aspects of STEM (McClure et al., 2017). A newly developed "whole child" curriculum, the Early Learning Matters (ELM) curriculum for preschoolers (ELM Curriculum Development Group, 2018), demonstrates a more intentional approach to address STEM in ECE with the learning domains of math, science, and creative expression clearly represented as part of the eight targeted "foundation skills." Although this is a strong stride forward to purposefully scaffold STEM understanding in ECE curriculum, the integration of experiences targeting engineering and technology are more subtle—for example, with reference to block-building experiences. The kinds of activities proposed in ELM are not as robust as the Ramps and Pathways project, that is, "a curriculum that encourages children to build structures of roller-coaster-like ramps using simple wood trim, balls, and other rolling objects" (McClure et al., 2017, p. 16; Counsell et al., 2016), in addressing simple tools (e.g., ramps) and application. To appropriately target all aspects of STEM, ECE professionals need strong professional development, preservice training, and appropriate resources and supports (e.g., a clear, comprehensive curriculum) to help foster important ECE skills and knowledge.

Implications of the Head Start and Early Head Start Programs

Head Start, a microsystem for many children living in the United States, is a federally funded program created to enhance social and academic readiness skills for low-income children between the ages of 3 and 5 (Wen et al., 2012). While encouraging parents and caregivers to maintain an active role in their child's learning, Early Head Start provides community resources for infants, toddlers, and pregnant women (Ohio Department of Education, 2021). For the 2018–2019 academic year, the number of non-Hispanic White and Black children enrolled in Head Start was 24.1% and 30.5%, respectively (Office of Head Start, 2019). Furthermore, 28.8% of non-Hispanic children enrolled in Early Head Start are Black, compared with 24.6% White children (Office of Head Start, 2019). These figures suggest that Head Start and Early Head Start offer a valuable opportunity to increase early STEM learning experiences for children of color.

Research provides a strong correlation between children's early acquisition of math and science knowledge and skills and their future academic performance on those subjects (Archer et al., 2010; Duncan et al., 2007). However, concerning the integration of STEM curriculum into Head Start and Early Head Start curricula, research in this area is limited. Lyon et al. (2012) argued that all children will benefit from interventions and programs involving STEM concepts, especially those from underrepresented communities. Consequently, such interventions will help children to develop and pursue an interest in STEM-related majors and professions. From a young age, quality STEM curriculum and opportunity should be centered around children's interests to encourage active engagement and successful programming (Aldemir & Kermani, 2017).

In addition, Nores and Barnett (2014) concluded that there is a disparity of math knowledge and skills between children from low-income families and their middle-upper-income counterparts; the achievement gap grows as the race and ethnicity of Black, Latinx, and Native American children are considered in relation to their income status. Aldemir and Kermani (2017) advocated for the developmentally appropriate integration of STEM concepts in early childhood education to support a child's curiosity and problem solving and critical thinking skills, as well as their ability to work on a team. As STEM integration into preschool curricula requires ECE programs to improve the quality of education provided to children, it will likewise challenge early childhood educators to recognize their role in supporting the prerequisite skills necessary for children to learn more advanced math and science in their later lives (Aldemir & Kermani, 2017).

Differential ECE Experiences

The National Association for the Education of Young Children (NAEYC; 2019) released a critical position statement, Advancing Equity in Early Childhood Education, which emphasizes that "all children have the right to equitable learning opportunities that enable them to achieve their full potential as engaged learners and valued members of society" (p. 5). A main purpose of this position paper was to outline how those working in the ECE profession, as well as how leadership and systems that support ECE, can "eliminate differences in educational outcomes as a result of who children are, where they live, and what resources their families have" (NAEYC, 2019, p. 4). The position statement acknowledges the research-based evidence that children's ECE experiences are not equitable and particularly that children of color, and their families, are less likely to receive the kinds of education and supports that prepare children to be successful in formal schooling and beyond (Nores & Barnett, 2014). This inequity is embedded within the sociohistorical context of the United States, and professionals and leaders must individually and collectively work to fight systemic racism, and the systems of privilege and oppression, that influence all aspects of ECE—including how it is funded, the composition and credentials of the ECE workforce, which children have access to high-quality ECE, and what is taught within ECE settings.

Although, to our knowledge, there are no specific studies examining whether young children receive differential treatment or experiences in STEM education within ECE classrooms, we do have a plethora of evidence that children of color, particularly Black and Brown children, experience different access to quality ECE settings and different treatment within classrooms in other domains of ECE. For example, Nores and Barnett (2014) highlighted that there is a significant kindergarten entry achievement gap in reading, and more profoundly in math, between White children and Black children and between White children and Hispanic children. Indeed, compared with White children, Black children are less likely to be enrolled in quality preschool programs (Nores & Barnett, 2014) or have access to high-quality state-funded preschool (Gillispie, 2019). In addition, despite the fact that Black children produce higher-quality oral narratives and demonstrate greater narrative comprehension (e.g., storytelling) compared to White children (Gardner-Neblett et al., 2012), ECE professionals may not always understand or value the oral language or conversational style of Black children and thus may view their contributions as deficient or delayed (Gardner-Neblett et al., 2012). By catering to Black children's confidence in oral narratives, perhaps by scaffolding with the use of more STEM language in school and at home, we can help remedy some of the differences in STEM achievement between Black and White children that appear later on in their education (Gardner-Neblett et al., 2012). In addition, we have mounting evidence that excited and age-typical assertive behavior, when exhibited by children of color, particularly Black and Brown boys, is often interpreted more harshly by ECE professionals and that young children of color are more likely to face expulsion from ECE programs, thus impacting their access to quality ECE (Gilliam et al., 2016).

Leveraging Community Spaces for Learning

STEM learning opportunities in informal settings in the community can serve an important role in making STEM accessible for all children. Not all children attend preschool, and by introducing learning opportunities to the spaces where families already spend time, we can lessen the experience gap that otherwise might occur. One effort to introduce more learning opportunities into spaces where families and children already spend time is the Playful Learning Landscapes initiative, a nonprofit organization in the Philadelphia area that works on projects to bring learning opportunities into public spaces (Bustamante et al., 2020; Pritulsky et al., 2020). One effort transformed an urban bus stop into a play space (Hassinger-Das et al., 2020). Before the transformation, families spent little time at the bus stop and had few conversations; however, after the transformation, families spent as much time at the new bus stop as a nearby playground and used more language, especially language related to learning concepts like numbers, letters, and spatial language (e.g., words describing shapes or sizes). Another effort took advantage of "play streets," an effort by the city of Philadelphia to close certain neighborhood streets to vehicular traffic during summer to provide a safe place for play (Schlesinger et al., 2020). Researchers worked with a community-based organization to train local teens to organize playtime on the play streets and in local libraries. The program not only provided play opportunities for children, including opportunities for asking questions, creativity, and physical play, but also served as skill building and confidence building for local teens (Schlesinger et al., 2020). While the Playful Learning Landscapes movement has been limited in scope, it provides a framework for how community-based opportunities can be implemented, offering access for children who might not otherwise interact with formal learning spaces.

While introducing learning opportunities into public spaces has great potential in increasing learning prospects, more traditional public learning spaces, like museums, also play an important role in early learning. In museums, curators can design exhibits that introduce families to learning concepts that can be used once they leave the museum as well. Sobel et al. (2020) found that parents setting goals with their children when learning about electrical circuits predicted children's ability to solve electric circuit challenges. Polinsky and Colleagues (2017) developed scripts for parents to use in a children's museum exhibit around a block wall exhibit. By providing parents with a framework to engage in guided play, not only did parent's spatial language use increase, but children also showed short-term gains on a spatial assessment. Similarly, Braham et al. (2018) found that introducing guiding questions to parents around budgeting increased both parents' and children's use of number talk relative to that exhibited by families given guiding questions around healthy eating. Additionally, the children in the budget question group performed significantly better on a number task after their play than children in the healthy eating question group. Both these studies show how museums can influence the types of conversations that families have around STEM concepts.

Recommendations

This article illustrates the systematic barriers that impede upon equity in STEM achievement, specifically for Black and Brown preschool students. With the hope of establishing new trajectories for children of color as they enter K-12 schools, our call to action below emphasizes the ways in which communities, ECE programs, families, and the broader U.S. society, from Bronfenbrenner's ecological perspective, can support children's early engagement and success in STEM. Our hope is that these recommendations, if taken up collectively in action, will provide Black and Brown children the opportunity to gain knowledge in STEM to support later learning and ultimately provide them a competitive advantage similar to that of their peers.

From a macrosystem and ecosystem perspective:

(1) Ensure that children of color have access to high-quality ECE programs. Friese and Colleagues (2017) provide clear guidance for policy makers and researchers about how to define and measure access. These guidelines include 23 specific indicators that can help policy makers identify areas of need within their communities, including things like "What is the percentage of households with children age 5 and under that speak a home language other than English, by county?" (p. 20) and "What is the gap between the availability and demand for high quality ECE in a geographic area?" (Friese et al., 2017, p. 13). Communities who follow these suggestions can set up policies and procedures to execute and monitor ECE access for marginalized children, removing the economic barrier to high-quality ECE that many families face.

(2) Ensure that preservice training and ongoing professional development for the ECE workforce includes information on:

a. The importance and value of STEM in ECE and general practices that support early STEM knowledge and skills.
b. How to create and sustain inclusive and equitable ECE programs, and actively engage in antibias and antiracist practices in their work, to negate the impact of implicit or explicit bias on young children of color's experiences.
c. How to teach STEM in ways that are culturally relevant to children of color. Recognizing the diversity of the ECE workforce in terms of training and supports (Whitebook et al., 2016), communities, and the broader U.S. society must take a multipronged approach to ensure that providers in center-based and family-based programs, whether public or privately funded, have these professional development supports.

(3) Ensure that the ECE workforce has curricular supports to adequately implement

a comprehensive approach to STEM (McClure et al., 2017), perhaps by using more comprehensive, developmentally appropriate curricular options such as the ELM curriculum (ELM Curriculum Development Group, 2018).

(4) Recognizing the importance of mesosystem interactions to ensure that STEM-related experiences in ECE programs engage children's families. Recognizing Black boys demonstrate a more successful transition from preschool to kindergarten when families provide enriching opportunities in the home (Iruka et al., 2014), ECE programs must intentionally plan ways to coordinate with families on this domain of learning.

(5) Ensure that there is adequate funding for ECE-focused STEM research, including research that examines equity issues with regard to STEM access and instruction and engagement of families. Compared with NSF funding for older children, college students, or career professionals, there are almost no federal research funds invested in ECE STEM-related projects (McClure et al., 2017).

(6) Ensure that families have access and support to materials and culturally relevant ways to embed STEM learning in everyday interactions and experiences and that families of color have relevant and tangible ways to interact with professionals of color who work within STEM fields. These efforts might include facilitating community outreach events where STEM researchers from local universities meet with children and families—for example, having scientists of color bring a microscope to a local fair.

(7) Ensure that communities prioritize offering accessible and engaging STEM-related community experiences and environments—for example, building off the work of Hohenstein and Tran (2007), targeting and leveraging spaces and events that are most relevant to families who may lack access to other formalized educational settings.

From a microsystem perspective, for all immediate contexts in which children interact: STEM learning can be as simple as asking questions. To enhance children's learning, families and ECE providers should be offered support and simple resources to incorporate more questioning in their interactions. STEM learning can happen anywhere and anytime, and if caregivers are confident in their ability to initiate and sustain conversations, children will have many more opportunities for building their early STEM knowledge.

In the United States, young Black children face systematic barriers to their entry into STEM, from lack of role models to underfunded schools. Opportunities to combat these inequities, however, exist at all levels of systems in children's lives, from the interactions children have at home with their parents to large-scale federal efforts to reform early childhood education. This article serves as a call to action for parents and families, teachers, researchers, and policy makers to make the changes needed to offer Black children, and other children of color, the opportunities to learn, grow, and achieve in STEM fields.

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