[Image description: Masculine-presenting adult of Color helping feminine-presenting child of Color with homework.]

Equity by Design:

Centering F.a.M.I.L.Y in Black Girls' STEM Learning

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This learning space is like no other! I feel welcomed, free from adverse consequences, encouraged to share, and uplifted! ~Caregiver

This learning space takes time on stuff, and actually focuses on stuff that can be useful in life. ~ Scholar

Girls STEM Institute (GSI) empowers Black girls to live their best lives and embrace their innate brilliance through STEM exploration. Through a socially

KEY TERMS

Holistic: The relationship between mind and body, the relationships among various domains of knowledge, the relationship between the individual and community, the relationship to the earth, and our relationship to our souls (Ron Miller, 2007p. 13).

Counterspace: Social and academic safe spaces that allow historically and contemporarily marginalized students to promote their learning through the validation of their knowledge and lived experiences, share stories about their racialized experiences, challenge and deconstruct deficit notions about historically and contemporarily marginalized groups, and build a positive racial climate for themselves (Solórzano & Villalpando, 1998).

transformative STEM curriculum, GSI addresses issues of inequity, racism, gender bias, and other stigmas as social constructs that can be overcome and

dismantled. GSI is unique in that it focuses on the whole person through integrating STEM learning with overall wellness and well-being.

In this *Equity by Design* brief, we describe the F.a.M.I.L.Y (*Fostering and Maximizing Interdisciplinary Learning Year-round*) Project and discuss the Project's importance and impact on Black girls and their caregivers. We end with a discussion of strategies implemented during the F.a.M.I.L.Y Project to create a holistic and inclusive environment for STEM learning and positive STEM identity development.

Why the F.a.M.I.L.Y Project?

This space allows for my daughter and I to learn together. As a result, we strengthen our bond. ~Caregiver

I feel more engaged, and I am eager to learn more. ~Scholar

Black girls face unique challenges within traditional educational spaces because of their historically marginalized gender and

racial identities (Evans-Winters, 2011; Joseph et al., 2016; Neal-Jackson, 2018). Research shows that Black girls start off holding a higher value for mathematics, higher confidence level and higher aspirations for STEM careers, but this does not lead into enrollment into higher-level courses (Walker, 2007) or increased entrance into STEM careers (Joseph, 2017). Despite Black girls' favorable view of themselves as learners and confidence in their academic abilities, they are disproportionately labeled "lower-ability," and tracked into very dehumanizing learning spaces devoid of opportunities to engage in higher-order thinking, and to draw connections between content and their lived experiences (Hill, 2010; Joseph et al., 2016; Smith-Evans et al., 2014). These decontextualized and depersonalized learning spaces often cause Black girls to become indifferent to and uninterested in mathematics (Gholston, 2016) and other STEM content areas.

We also know that caregivers play a significant role in supporting Black girls' development as STEM learners. Caregivers can encourage or discourage interests in STEM as early as preschool and late elementary (McPherson, 2014). Caregivers also have insights into their children's interests and dispositions, and can help make STEM more relevant to their children's lives (McCreedy et al., 2018). Connecting with caregivers is a priority for improving Black girls' mathematics confidence (Young et al., 2017).

Black girls greatly benefit from inclusive learning environments that take into account their lived and social realities, both inside

and outside of school (Joseph & Alston, 2018; Morton & Smith-Mutegi, 2018) and intentionally take on the pathos of the village

> The village is a realm where elements of love, support, care, and stimulation are coupled with academic rigor. In this way, the village is more than a mere emotional escape from the harsh and isolating realities of the formal classroom; it is a nucleus shaped around the principles of empowerment, enrichment, and exposure, such that the holistic betterment of the student is the ultimate goal. (Morton et al., 2020, p.10).

The F.a.M.I.L.Y Project centers on the pathos of a village to create an inclusive counterspace (Ong et al., 2018) for Black girls and their caregivers. The space exists to redress the dehumanizing experiences Black girls and their caregivers may experience in more traditional schooling spaces. The F.a.M.I.L.Y Project is vital because Black girls excel when given a chance (Joseph et al., 2016).

What is the F.a.M.I.L.Y Project?

The 2020-2021 F.a.M.I.L.Y Project provided Black girls and their caregivers an opportunity to collaboratively complete life-enriching, multidisciplinary, and socially transformative STEM experiences virtually and in person. Through the project, we provided holistic learning experiences centered on STEM content knowledge, and addressed Black girls' overall wellness and well-being. Within this inclusive counterspace, Black girls and their caregivers could be their authentic selves and their knowledge was validated. This year-long project aimed to explore how

these learning experiences impact Black girls and their caregivers' enjoyment of STEM, interest in STEM content and careers, and understanding STEM as a tool for personal and social change.

[Image description: Feminine-presenting child of Color wearing protective eyewear.]

During the 2020-2021 F.a.M.I.L.Y Project, scholars and caregivers engaged in ten online learning sessions, in addition to one in-person session. STEM kits with materials for each session were mailed or hand-delivered to participants' homes. Black girls and their caregivers engaged in learning experiences related to chemistry, forensic science, mathematics and food insecurity, geography, organ donation, and financial wellness. Learning experiences during the F.a.M.I.L.Y Project were framed using a socially transformative STEM curriculum framework.

Mutegi's (2011), 5c's (Content, Currency, Context, Critique, and Conduct) Socially Transformative STEM Curriculum Model centers around five areas of mastery for learners. When creating curricular content to address the five areas of mastery, the following questions were considered:

1) "What is X?" Here X could represent any mathematics or science concept?"(p.310)." **(Content)**

2) "How and where is X relevant to mankind in modern life"? (p.310)?" **(Currency)**

3) "In what ways is X important to people of African descent"?(p.311)?" **(Context)**

4) "How can my understanding of X help me to understand systemic racism"? (p.311)?" **(Critique)**

5) "How can I use my understanding of X to improve the social conditions of people of African descent"? (p.311)?" **(Conduct)**

One example of the F.a.M.I.L.Y Project's socially transformative learning experience is the *Human Cacti* workshops. This series of workshops focused on food insecurity through the lens of mathematics (see call-out box on the next page).

As Black girls and their caregivers engaged in *Human Cacti* and other socially transformative learning experiences, they strengthened their skills and increased their academic capital (Bourdieu, 1986). Not only was there a transference of multigenerational knowledge at play, but the intentional design of a safe and liberating space for Black girls and their families was also crucial to fostering positive STEM identity development.

Workshop Example: *Human Cacti* | Author: Mr. Evan Taylor

GOAL/OBJECTIVE:

Participants will use and apply understandings of proportional reasoning, cartography, and food science to evaluate inequities in access to healthy food options in certain zip codes.

CONTENT:

At the beginning of the session, participants engaged with a slow-reveal graph showing the locations where food deserts were within the United States. This led to a discussion around what foods are considered healthy, which places within participants' communities provide access to healthy food options, and how far individuals had to travel to get access to healthy food options. After participants were shopping vocabulary terms and the mathematics rooted in the terms (food desert, food swamp, food mirage, food insecurity), they were given a zip code and were told to classify the neighborhood. Conversations were then rooted in what changes could occur within the communities to offer food justice, and what had been done in other communities to deal with similar problems of injustice.

Impact of the F.a.M.I.L.Y Project

In this section, we use participants' words to discuss the impact of the of the F.a.M.I.L.Y Project. We center this discussion around three themes (1) deeper appreciation for STEM, (2) interest in STEM and STEM careers, and (3) discovering societal issues while exploring STEM subjects to emphasize that STEM learning in collaborative spaces enhances learning experiences and interest in STEM for Black girls and their caregivers.

Deeper Appreciation for STEM

As a result of participating in the F.a.M.I.L.Y Project Learning Experiences, Black girls and their caregivers described gaining a deeper appreciation for STEM. The data revealed that all participants appreciated STEM, but the caregivers' affinity for STEM heightened after the F.a.M.I.L.Y Project. For example, in their journal entries, participants describe their deeper appreciation:

> *I have always loved science but every time I learn something the love for it grows stronger. ~Scholar*

> *I appreciate STEM even the more. ~Scholar*

> *I've had an appreciation for STEM for a long time. Today's session further strengthened my appreciation. ~Caregiver*

> *I have even the more appreciation for STEM activities. ~ Caregiver*

There was a consistent pattern in participants' heightened appreciation for STEM based on the theme of the learning session. The *Human Cacti* activity was the most popular session. F.a.M.I.L.Y Project participants stated that the learning experience contributed to their understanding of STEM in real-world applications. Generally speaking, the learning experience with mathematics and food deserts fully engaged their appreciation for STEM concepts outside of the traditional classroom, provided an opportunity to critically analyze food deserts and food mirages in surrounding Indianapolis neighborhoods, question who is responsible for food insecurity, and connect to larger societal issues.
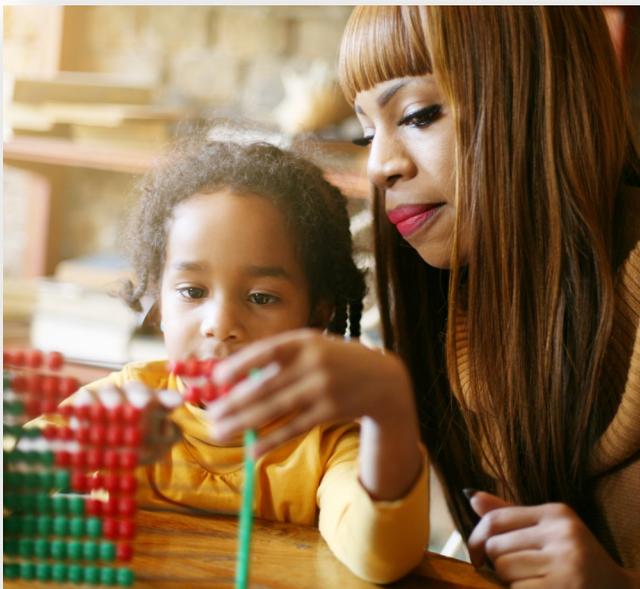
[Image description: Feminine-presenting adult of Color helping feminine-presenting child of Color with counting.]

Discovering Societal Issues While Exploring STEM Subjects (understanding STEM as a tool for personal and social change)

Each F.a.M.I.L.Y Project facilitator incorporated a holistic approach to their learning sessions. Whether it was a kitchen science activity, or a lesson on Henrietta Lacks, participants were introduced to STEM concepts applicable to real-world scenarios. More specifically, participants mentioned the connections made outside of the learning environment after each session. For example, participants detailed their interpretation of STEM concepts as it related to their everyday lives:

I learned about how poverty is systematic to keep you at a certain level of wealth so others higher up can benefit. I could use what I learned today to motivate myself and others to not fall victim to the system. ~Scholar

I've been reminded of how important it is to include, well, first of all, that there's science everywhere and there's math everywhere…this kitchen science and including more math and science and pointing out technology in the everyday things we do is one of the biggest things that I've learned…just being able to include, be more aware that it is everywhere. It's not just in a classroom. It is everywhere. ~Scholar

It's helped to further validate how STEM subjects and STEM activities literally are embedded in everything

that you do. So, it helps kind of reinforce the fact that we can learn STEM when we're baking in the kitchen, we can learn STEM when we're doing everyday things when we go to the grocery store when we're on a hike. So, I think, again, it helps to reinforce how broad STEM can be when you're learning and teaching your kids. ~ Caregiver

From their interpretation of the lessons, Black girls and their caregivers reported how STEM concepts are included in everything we do. Therefore, creating more opportunities for caregivers to engage their scholars with STEM concepts outside of the traditional STEM learning environment is critical.

Furthermore, the F.a.M.I.L.Y Project Learning Experiences impacted Black girls and their caregivers' consciousness of societal and cultural issues, specifically the lessons on organ donation and mathematics and democracy. The participants stated the intentionality of these F.a.M.I.L.Y Project Learning Experiences, coupled with the small group setting and their lived experiences, contributed to their awareness and understanding of STEM as a tool for personal and social change. For example, participants describe their understanding of the interconnectedness of STEM and societal issues:

The topics have sparked dialogue with people in my immediate family… the organ donor topic…understanding of this topic on a social and cultural level as to why African Americans aren't fond of being organ donors. ~Caregiver

Look at the divide of inequity…just opened our eyes up to how all of this is related, STEM and equity, poverty and oppression of communities. ~Caregiver

I can consider working in food market business or farming business to help other black communities in food deserts. ~ Scholar

STEM could help us understand, I guess the root causes of some of the societal ills and also identify and theorize as far as what the solutions could be. ~ Caregiver

I learned about how poverty is systematic to keep you at a certain level of wealth so others higher up can benefit. ~ Scholar

The caregivers were very engaged in these learning experiences. Caregivers shared personal testimonies about community gardening, their childhood experiences within the changing local communities, and medical mistrust that added rich content to the discussions.

Interest in STEM Content and STEM Careers

All participants reported an increased interest in STEM content and careers after each F.a.M.I.L.Y Project Learning Experience. More specifically, Black girls mentioned learning of new STEM career choices and concepts that could influence their futures.

> *Food security and insecurity was my favorite part of the project. I learned about a lot of STEM careers that I would have never known to exist. ~Scholar*

> *I can consider working in food market business or farming business to help other black communities in food deserts. ~Scholar*

> *I did not know STEM included financial jobs. ~Scholar*

Caregivers also describe how the learning experiences influenced their scholar's college and career choices:

> *Let me tell you something. My daughter…I don't know. I think she thinks she's some "Ms. Know It All" now…she's confident. She's confident about herself now. We have done talked about several things. And right now, I don't know… It's up to her on where she wants to go…but STEM has gave her the option. STEM has planted the seed in her head that there's other ways to go... My daughter…I hope, and I really got my fingers crossed that…I*

love science. So, I would love for her to be in science and doing something at NASA, but I doubt she'd go that way. But it would be nice if she did. ~Caregiver

> *I think the F.a.M.I.L.Y. Project encouraged them to know that there are different career choices out there aside from whatever they're thinking. Then with the career choices that are out there, college is just a given. I think the STEM project just made them aware of different career paths that they can go into. We talk about the genetic piece, we talk about the DNA piece, when you look at forensics. Just giving them different things that they can think about in terms of career choices for college. I think that could have expanded their knowledge for that. ~Caregiver*

> *She is going to choose a STEM career. She was on that path. But I noticed her talk about other career options. She's not as limited anymore. I could do this or I could do that. ~ Caregiver*

> *Well, she always knew that college wasn't an option. You got to do your four years. You got to do your time. Consider it like being drafted in the Army. You got to do your four years. But what this has done for her, again, it slowly but surely connecting her love of doing things with the things being STEM. She always likes to do the things, but didn't call it science, technology, engineering, and math. Didn't call it that. So that's*

the biggest thing that's happening is that the doing of the things and what the things are, are getting connected. ~Caregiver

Strategies from the F.a.M.I.L.Y. Project for Creating Inclusive Spaces for Positive STEM Identity Development

Aguirre et al. (2013) defines identity as how people conceptualize themselves and others: "Identities announce to the world who we think we are, who we want to become, or who we are not" (p. 14).

Identity construction is important to STEM learning because one's identity is a source of motivation and strength (Martin, 2000). Research shows links between positive STEM identity development and learners' academic and career choices, effort, persistence, interests, values, perceptions, beliefs and goals (Collins, 2018). A positive STEM identity is an important factor that can impact whether girls and women move into STEM-based careers (Kim et al., 2018).

Teaching for diversity and inclusion through role models, creating a sense of belonging, authentic learning experiences (Singer et al., 2020), and transformative learning experiences (Morton & Mutegi, 2022) are three contributors to the development of a positive STEM identity (Singer et al., 2020). Through the GSI: F.a.M.I.L.Y Project, we strived to create an inclusive environment in which Black girls and their caregivers felt a sense of belonging and had access to authentic and transformative learning experiences. We highlight four strategies, with for creating such an environment:

Build Authentic Caregiver Partnerships

- Supporting Student Success through Authentic Partnerships: Reflection from Parents and Caregivers

Create a Collaborative Learning Environment of Comfort and Care

- Appreciating Difference: Getting to Know Your Students and Families
- Caring & Affirming Educational Environments

Provide Socially Transformative STEM Learning Experiences

- Socially Transformative STEM Curriculum: What It Is and Why African American Students Need It
- The Inadequacies of Science for All and the Necessity and Nature of a Socially Transformative Curriculum Approach for African American Science Education
- The Molecules that Make Me Unique

Provide Access to STEM and Other Professionals from Diverse Career Backgrounds

- How to Foster the Formation of STEM Identity: Studying Diversity in an Authentic Learning Environment

Caregivers who participated in the F.a.M.I.L.Y Project were not new to Girls STEM Institute. They partnered with Girls STEM Institute through previous opportunities, with some caregivers being in partnership for seven years. Investing in building robust relationships with caregivers is vital because we cannot help to bring about systemic change without including caregivers.

During orientation, we reiterated that the GSI: F.a.M.I.L.Y Project was a space where participants' knowledge and expertise were valued and needed. Session facilitators, representing a variety of STEM backgrounds, provided learning experiences that centered on the knowledge of F.a.M.I.L.Y Project participants and issues relevant to their lived experiences. These learning experiences created opportunities for caregiver to caregiver, and caregiver to scholar dialogue, which was a vital and rich source of learning:

> *This space allows for my daughter and I to learn together. As a result, we strengthen our bond.* ~Caregiver

> *I learned to listen to my daughters more and hear how they process the world and how they process information.* ~Caregiver

> *I enjoyed spending time with my dad.* ~Scholar

Concluding Thoughts

With growing interests in STEM at both the national and international levels, and the perpetuation of racial disparities in academic and STEM career outcomes, educators must provide learning experiences that foster positive STEM identity development of Black girls (Morton & Mutegi, 2022). This brief provided an overview of the GSI: F.a.M.I.L.Y Project as way to highlight the importance of centering families in Black girls STEM learning. It also highlighted the ways collaborative learning between Black girls and their caregivers not only impacts their view of STEM content, but also impacts the familial relationship between caregiver and their children. McCreedy et al. (2018) states that "environments that promote collaborative learning experiences for children and adults are rare" (p.1). Girls STEM Institute, through the F.a.M.I.L.Y Project, is working to change this narrative. We see the F.aM.I.L.Y Project as a model for creating holistic and inclusive environments that foster positive STEM identity development and centers the usefulness and relevancy of STEM for both Black girls and their caregivers.

Through the GSI: F.a.M.I.L.Y Project, we strived to create an inclusive environment in which Black girls and their caregivers felt a sense of belonging and had access to authentic and transformative learning experiences.

About the Authors

Dr. Crystal Morton is an Associate Professor of Mathematics Education in the Department of Urban Teacher Education at IUPUI School of Education, where she serves as the Associate Dean of Research and Faculty. She also serves as Associate Director of Research for the Great Lakes Equity Center, and board member for TechPoint Foundation for Youth. She is also the founder and director of Girls STEM Institute. Dr. Morton's scholarly work focuses on secondary mathematics education, emphasizing the role of informal STEM learning in fostering equitable and transformative mathematics teaching and learning experiences. She primarily examines the learning experiences and specifically mathematics learning experiences of Black girls in grades 3-12.

Chanae Palmer-Azikiwe serves as the Director of Community Partnerships for Girls STEM Institute. She has over six years of experience in fundraising, prospect research, event planning and program development across diverse non-profits, including education, health, social services and civic advocacy organizations. Her dedication and passion for advocating and fundraising led her to become a Hearst Fellow for the Lilly Family School of Philanthropy in 2015. She holds a Master's Degree from the Lilly Family School of Philanthropy in Indianapolis, and a Bachelor's Degree in Family Sciences from Towson University in Maryland. She is currently a doctoral student in the School of Urban Education at Indiana University Purdue University Indianapolis. Her research interests focus on the collaborative power of philanthropic institutions and small nonprofit agencies.

Marva Renee Barlow is passionate, dedicated, and enthusiastic about students' growth and achievement in academics as well as social and emotional growth. She has committed approximately ten years in education working to increase students reading and math skills and with families to enhance their students' academic knowledge base. She has worked with Girls STEM Institute from its inception as the Family Engagement Liaison and as the Assistant Director. She is also the Founder of Future Forward Educational Services.

About the Midwest & Plains Equity Assistance Center

The mission of the Midwest & Plains Equity Assistance Center is to ensure equity in student access to and participation in high quality, research-based education by expanding states' and school systems' capacity to provide robust, effective opportunities to learn for all students, regardless of and responsive to race, sex, and national origin, and to reduce disparities in educational outcomes among and between groups. The Equity by Design briefs series is intended to provide vital background information and action steps to support educators and other equity advocates as they work to create positive educational environments for all children. For more information, visit http://www.greatlakesequity.org.

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