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TechArts & Crafts: Supporting STEM Capital Development for Marginalized Students

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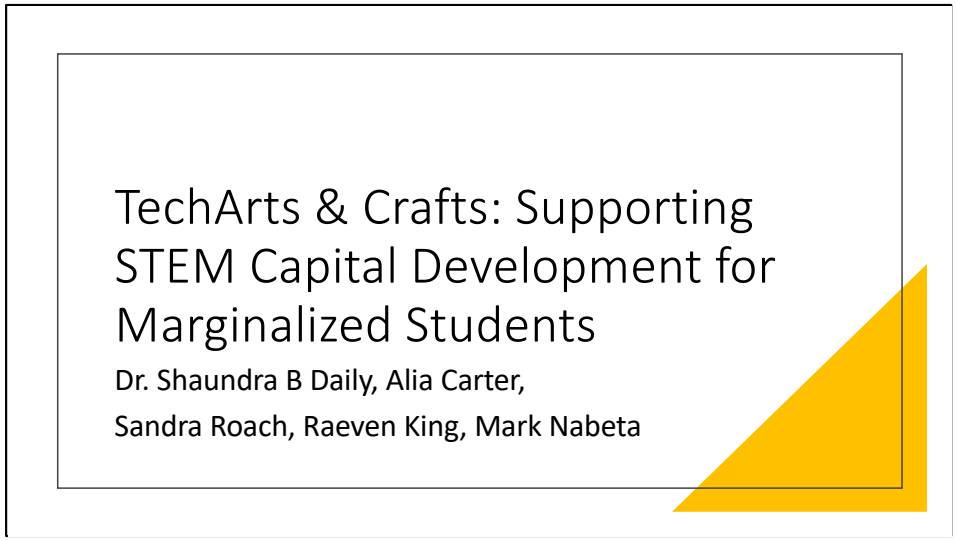
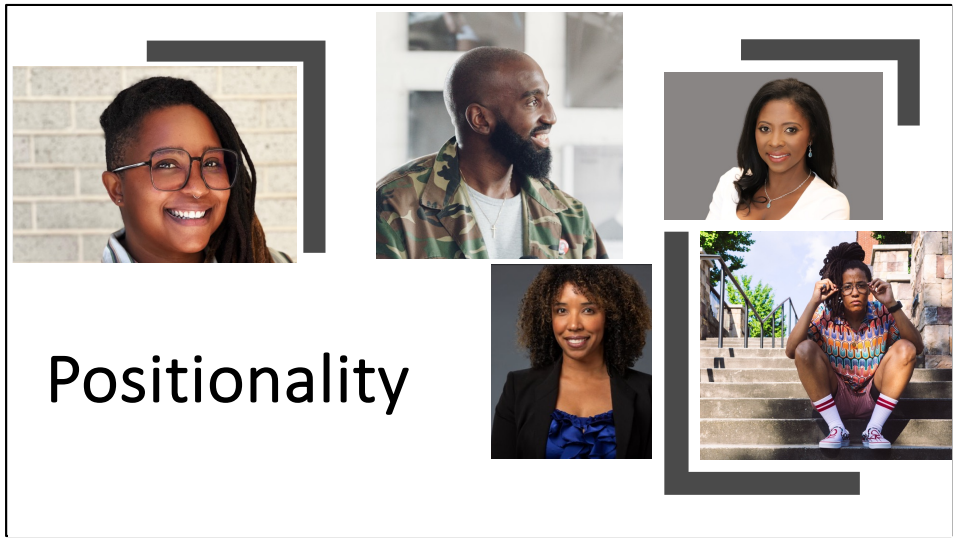
Mrs. Sandra Roach
Alia Carter
Raeven King
Mark Nabeta



Good morning/afternoon. I'm here today to present a model my colleagues and I have developed to attract and retain students from marginalized backgrounds in STEM fields, specifically computing. As I'll underscore, diversity is critically lacking and imperative, both from an equity perspective and to further innovation and problem-solving abilities in the field. Our model focuses on building "STEM capital" - that is, the skills, attitudes, knowledge and experiences that enable participation in these fields. We do this through creative computing workshops that integrate art, music, design and gaming to spark passion and a sense of belonging. Through a

collaboration with The Whitaker Group, a fashion industry partner with strong community ties and "street credibility", we aim to validate STEM as a viable, relevant, and aspirational path, particularly in the communities we hope to reach. I'm excited to tell you about our model and workshops with the ultimate goal of dismantling systemic barriers and equipping talented, passionate students to see themselves thriving in computing careers.



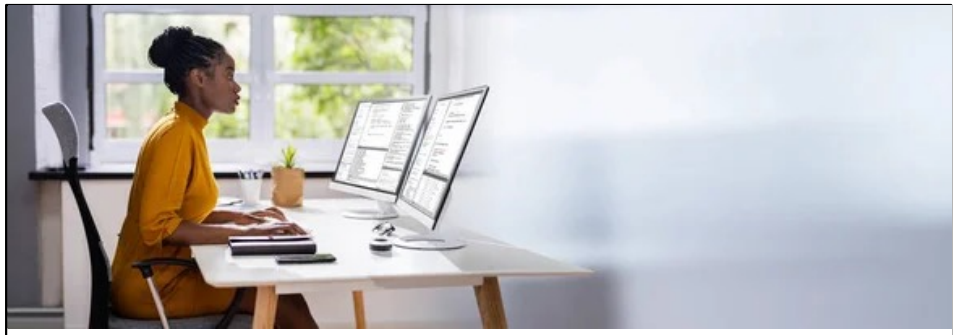
- Before diving into our presentation today, each of us will give a brief positionality statement to situate our perspectives in this work.
- Hello, my name is Alia Carter. My pronouns are she/her. I am an able-bodied, cisgender Black woman living in the United States. I am a research scientist in the electrical and computer engineering department at Duke University. I have worked in informal and formal STEM education for the past 15 years including serving as the director of science engagement at a science center and teaching math and

science at a Jewish Day School. I use my position and privilege to address inequities in STEM education and strive to stay mindful of my biases and assumptions based on my experiences and opinions.

- Good morning, my name is Sandra Roach . I am a Black, able-bodied, cisgender woman of Caribbean decent. I am a research associate in the electrical and computer engineering department at Duke University. I am a first-generation immigrant, one of seven children raised in a two-parent household, and the first to graduate college in my family. I have worked in education for over twenty years and entrepreneurship for fifteen years running my tutoring company that focuses on building foundations in STEM. My current role allows me to foster environments of diversity, creativity, and collaboration.
- Hi everyone. My name is Shani Daily. I am a Black, able-bodied, heterosexual, cisgender woman with an interdisciplinary computing Ph.D. I am a senior faculty member in an electrical and computer engineering department at Duke University. I was raised in a lower-middle-class, single-parent household and was introduced to computing as a college student pursuing an engineering degree. I have worked in academia for twenty years, centers my research on DEI in computing, and currently work

with industry partners to recruit women into computing careers.

- Our collaborators, mark Nabeta and Raeven King are not here with us; however, they are crucial for the collaboration to be successful.



Shakayla's Story

- We're going to kick things off by sharing Shakayla's story. And while this is just one person's story, she represents the experiences of so many marginalized students in STEM.
- Shakayla grew up in a Black working-class family in Detroit. Her mother worked as a secretary and her father was an auto mechanic.
- From a young age, she found joy in taking things apart to see how they worked. She would disassemble old radios and appliances in the garage
- In high school, she excelled in math and science

classes. Her parents, who had not attended college, were incredibly supportive of her interests but weren't able to provide much guidance.

- When it came time to apply for college in the mid-90s, her math teacher took her aside and asked had she considered computer science.
- She barely knew what engineers did - no one in my family or community was an engineer. But that encouragement opened her eyes to new possibilities.
- Unfortunately, her school had very few options for AP coursework and no exposure to engineering.
- Eventually she entered college, and her first year was a big challenge.
- She was overwhelmed and often felt out of place as one of the only women of color in her engineering classes.
- The competitive, individualistic culture did not come naturally to her. She wanted to collaborate and help lift up her classmates. But working together was seen as weakness, even cheating.
- Outside of class, her peers seemed to have lots of coding experience that she didn't have. There was an assumption that they all came in with the same baseline knowledge. She had to work twice as hard just to catch up.
- She also had to work, and the homework load

assumed that school was the only thing she was doing.

- Being part of the National Society of Black Engineers gave her community and strength when she felt isolated in her program. But these activities, along with her part-time job, led some professors to see her as not serious about her studies.
- In her senior year, she applied to an REU summer research program at a top school. When she asked her assigned advisor for a recommendation, she was told that given her grades, he wasn't sure she would do well. But she applied anyways. And got the position.
- The opportunity allowed her to demonstrate how capable she was, and eventually, she earned a master's degree which led to a high paying job with Facebook in Austin, Texas when she graduated.
- This was 20 years ago, so you may be thinking - surely things have improved since then! Unfortunately, many of the same systemic barriers persist. As many of you already know, students from marginalized backgrounds still face major obstacles entering and succeeding in STEM.

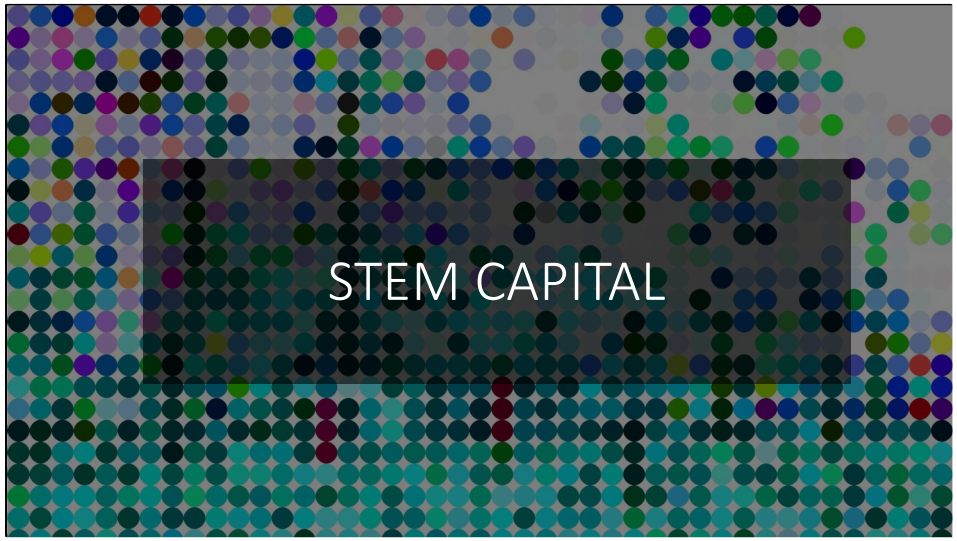
- Students from marginalized backgrounds still face major obstacles entering and succeeding in STEM.
- As the research shows, STEM fields remain disproportionately white, Asian and male, especially at all levels.
- Culture and policies are still not designed for women, students of color, first-generation students, LGBTQ+ students, students with disabilities, and others outside the typical mold.
- In 2021, just 3.9% and 9.6% of bachelor's degrees in computer science went to Black and Hispanic

students. And 22% to women. When you look at these data intersectionality, the numbers decrease. For example, Black women represent only 2.6% of computer science degrees.

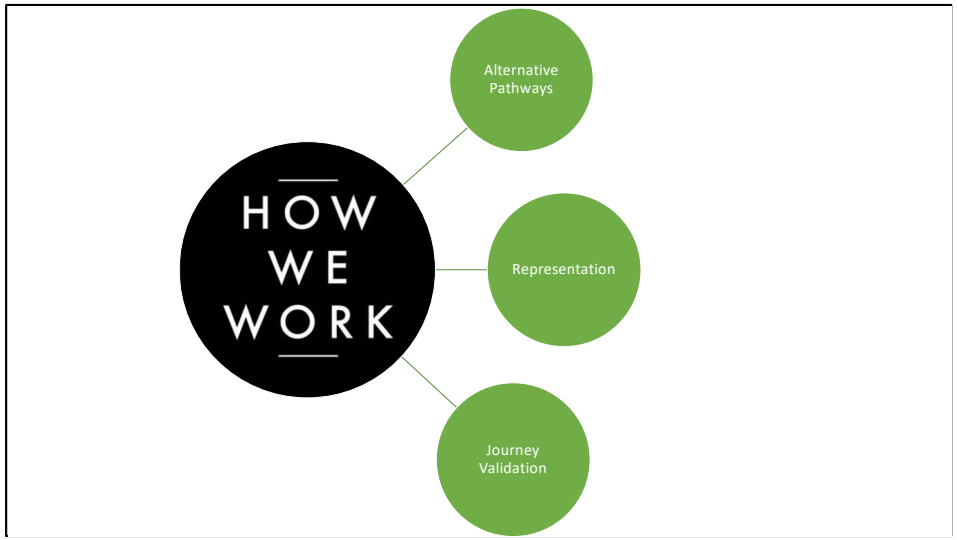
- Diversity in computing is an equity issue, full stop. We need no other motivators to address this issue.
- AND we are also aware of the implications for having diversity in computing
- Embracing diversity unlocks innovation and problem-solving.
- If we hope to address complex societal challenges through STEM, we absolutely must tap into a broader range of perspectives and experiences. This imperative brings us together today.
- So how do we attract and retain diverse groups? What

will it take to foster a true sense of belonging? The model we will discuss aims to do just that by focusing on the development of STEM capital.

- With inclusive strategies like creative engagement, representation, and counter-messaging, we can make progress toward equity in computing fields.



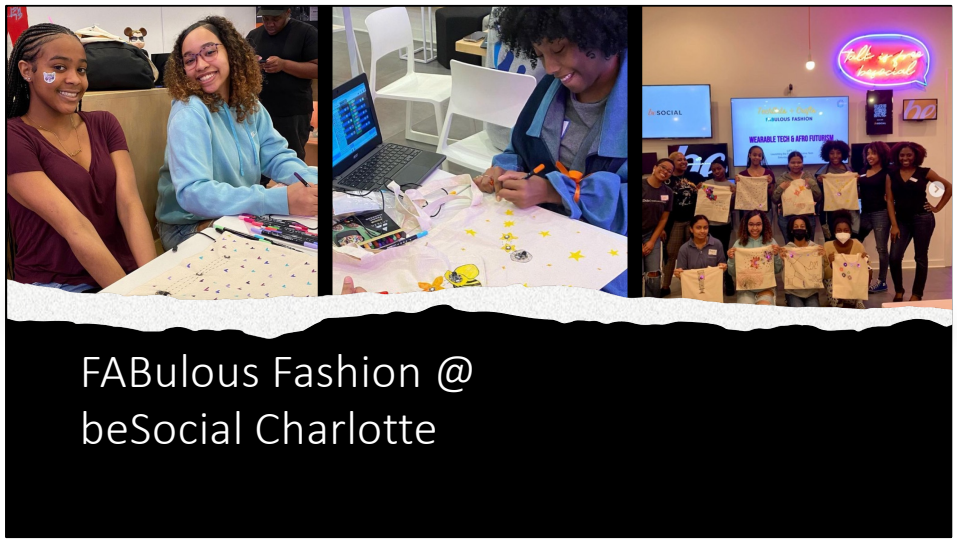
- First and foremost, our model is grounded in the concept of STEM capital. This refers to the constellation of skills, attitudes, knowledge and experiences that shape participation in STEM fields. Rather than taking a deficit view, it focuses on building capital.
- STEM capital is an extension of the concept of science capital which was developed by researchers at King's College London to help understand why some young people see science as "for me" and others do not.



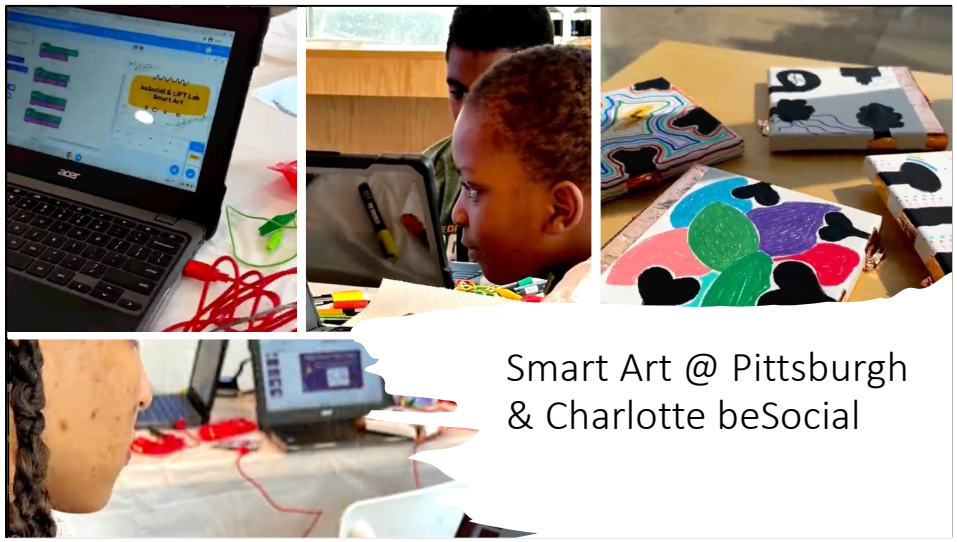
- Our workshops incorporate three key strategies targeting STEM capital development. These involve creative applications, representation, and journey validation.

Creative Applications for Alternative Pathways

- Let's start with creative applications. Since 2003, we have been exploring alternative pathways to engage with STEM areas like art, music, and dance. Our own research and the research of others has shown that providing these pathways can support both recruitment and retention of marginalized groups in STEM.
- For these workshops, we integrate STEM into non-traditional areas like art, music, dance, and fashion design. Using culturally relevant contexts provides vital on-ramps for students who may not see themselves in traditional STEM activities.



Let me give you a taste of some of the creative workshops we've designed. In one, students sew beautiful LED lights onto tote bags they've personally decorated. Through programming a micro controller connected to the LED, they make the lights shimmer in unique patterns that complement their artwork.



In another workshop, we have students paint canvases using conductive paints. They attach these paintings to Makey Makey invention kits, which connect to the visual-based programming platform, Scratch. When each conductive paint spot is touched, a circuit is completed activating different sounds and musical notes in their Scratch programs! This project fuses art and music composition in an incredibly inventive way.

In a similar workshops, students construct foil sculptures that connect to the Makey Makey invention kit and Scratch to trigger sounds and music when touched. Their imaginations shape both the 3D artwork and the sounds they design.

AMAZE-ing Creations @ beSocial Charlotte

And one of my favorites, students code maze games in Scratch using arrow keys to move characters through the levels. The students created a game controller out of Play-Doh which when connected to Scratch through the Makey Makey, to control the movements in the game. This turns coding into a hands-on game with physical Play-Doh controllers.

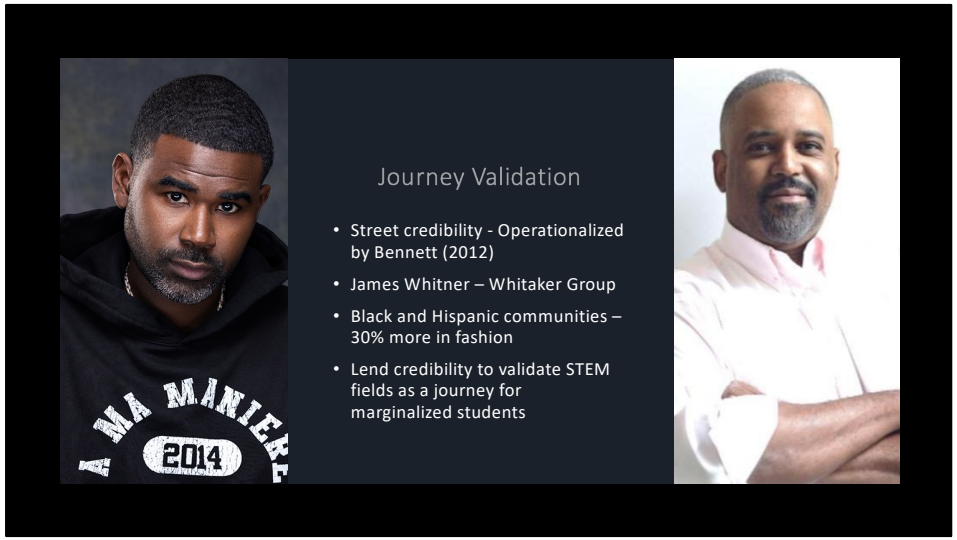
- Across all these creative applications, students see direct links between STEM and their own interests in art, music, design, and gaming. Making these real-world connections sparks passion and makes abstract coding feel concrete and achievable.

- Seeing STEM integrated with creative outlets relevant to their lives provides that vital sense of belonging. Students gain confidence that they can bring their full selves and talents to computing.

Making explicit connections between STEM and creative outlets relevant to students' lives gives them new visions of who can participate. With the ultimate goals of fostering a sense of belonging

- Representation is another cornerstone. We intentionally involve Black and Latina faculty, researchers and college students in the workshops.
- Note that we are not assuming that placing people at the front of the room will magically make a difference. Each of us have a longstanding commitment to DEI in STEM and have studied culturally-relevant pedagogical approaches. We also have years of experience in mentoring minoritized students in both formal and informal capacities.
- We serve as role models at each workshop. Seeing

people like yourself thriving in STEM builds community and belief in what is possible. It helps participants see that STEM is ”for me.”



- Finally, we leverage the idea of street credibility and cultural influence of our fashion industry partner. I know speaking of street cred may seem unconventional in this context! But please hear me out on its power here.
- According to Bennett and other researchers, street credibility springs from inner-city communities of color. It signals authenticity and confers respect.
- Our partner, The Whitaker Group, has deep street credibility rooted in the communities we aim to reach. They launched 18 years ago, and since then, they've

collaborated with major artists and brands while staying true to their community ties.

- Today, The Whitaker Group is a force with cultural cachet far beyond its roots. They have over 40K Instagram followers. This gives them a platform to reframe STEM as relevant and aspirational. Our goal in this partnership is to leverage their street cred in order to positively reshape perceptions of who belongs in STEM, building STEM capital.
- Having a brand with The Whitaker Group's authenticity publicly endorse our workshops sends a powerful message. It's a validation of STEM in an industry where Black and Latinx families spend 30% more than white counterparts. I'll note here that these spending patterns are not about race, they are about status. But regardless fashion is an important part of our communities.
- Through our partnership, the Whitaker Group leverages their network to spread the word to families and youth on social media and at their stores. This community-rooted brand signaling STEM as cool and credible can shift mindsets.

- By providing alternative pathways to engage with STEM content and see oneself as belonging in STEM, embracing role models with shared identities, and aligning with our partner to validate STEM as a viable field, we expect that participants will gain experiences that shape positive STEM identities and build STEM capital.
- There is still immense work ahead. Dismantling systemic barriers requires tenacity. But equipping passionate students with experiences reflecting their brilliance and belonging drives us forward.

At this time, we'll take questions
[anonymized]