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Research Paper

Measuring the Impact of Culturally Relevant Literature and Inquiry-based Activities on STEM Identity in Children

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Abstract

Out-of-school activities have the potential to broaden participation in STEM, especially for groups with less access to school-based opportunities. This mixed-methods, cross-sectional study aimed to engage families in STEM activities and provide culturally relevant books at a community-based STEM Family Night (N = 9) and a university-based summer program (N = 21). The objective of the study was to measure the project's impact on individuals' STEM identity and alignment with social justice constructs. Participants were invited to take two surveys: 1) Culturally Relevant STEM and 2) STEM Identity. A Justice-centered STEM Framework (JCSF) served as the theoretical framework, and both surveys included Likert-scale and open-response items. The research questions guiding this project include: 1) What patterns are seen in student participation across the two programs? 2) Do the survey responses support the JCSF and STEM identity, and what differences in survey responses exist between programs? 3) Do the open-response items reflect the constructs of JCSF? Data analyses included item and survey means, *t*-tests, and thematic coding. Findings revealed significantly higher scores on the Culturally Relevant STEM survey mean and on one item related to *confidence in STEM* for the summer program; *commitment to community* and *inspiring* were the most common themes. The highest-scoring subscales on the STEM Identity survey were *recognition by others* and *self-recognition*, and the most common themes identified were *authentic STEM* and *enjoyment and engagement*. This study supports the implementation of informal STEM events and the positive impact of culturally relevant books on individuals' STEM Identity.

Keywords: *Informal Education, Justice-Centered STEM Framework, STEM Literacy, Urban Education*

INTRODUCTION

Diversity in STEM

Historically underrepresented groups in Science, Technology, Engineering, and Mathematics (STEM) include first-generation college students, females, underserved racial and ethnic groups, and individuals from lower socioeconomic backgrounds (NCSES, 2023). These groups face barriers in pursuing a career in STEM outside of academic capabilities and struggle with an array of factors, including a lower sense of belonging, feelings related to imposter phenomenon, and a lack of a cognitive map or general understanding of how to navigate higher education (e.g., Collier & Blanchard, 2024; Gardner, 2013; Good et al., 2012; Kumar & Jagacinski, 2006). A critical factor affecting underrepresented individuals is a lack of self-efficacy, or a belief in one's ability to achieve one's goals (e.g., Estrada et al., 2016; Kahn et al., 2022; Lishinski et al., 2022). As technology advances, STEM fields must reflect society's creativity and diversity to thrive.

Prior research has shown that students prefer learning science through activities rather than just using textbooks (Bruder & Wedeward, 2003; Houston et al., 2008). However, most research focuses on secondary students in formal education settings, leaving gaps in the literature regarding elementary students and informal education. Because career identity begins in early childhood (Moote et al., 2020), the lack of research in this area can adversely affect underserved groups. Gaining insight into practices and pathways to address gaps in the STEM field through supports for underserved groups and younger students can contribute to current research knowledge and

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translate into productive practices to reach individuals historically underrepresented in STEM, e.g., females, first-generation students, and underrepresented racial and ethnic groups.

Prior research has supported the use of culturally relevant activities to engage students in STEM and to foster their sense of belonging, empowerment, and relevance (e.g., Ali & Bangalore, 2025; Marosi et al., 2021; Morales-Doyle, 2017). The current project distributed STEM trade books at several local events, providing insight into these less-studied areas. Science trade books are important curriculum materials for K-12 science classrooms and informal education settings. STEM-focused books can scaffold students' acquisition of science content, improve literacy skills, and support interest in STEM careers (NSF, 2020). Inquiry-based activities were paired with content aligned with the books. Participants at the events were invited to take two surveys: 1) Culturally Relevant STEM and 2) STEM Identity. Social justice constructs and a Justice-centered STEM Framework (JCSF) guided the data analysis, while the STEM Identity survey was administered to assess the project's impact.

The research questions guiding this project include: 1) What patterns are seen in student participation across the two programs? 2) Do the survey responses support the JCSF and STEM identity, and what differences in survey responses exist between programs? and 3) Do the open-response items reflect the constructs of the JCSF?

It was hypothesized that survey completion rates would be higher among summer program participants than among literacy center participants, as the summer program had previously been linked to research (H1). Secondly, it was expected that the survey responses would support the JCSF and STEM Identity and be similar between the two groups (H2). Lastly, it was hypothesized that the open-response items would provide evidence that students developed aspects of the JCSF through participation in STEM activities and reading culturally relevant trade books (H3). Findings from the analyses support implementing informal STEM education and the positive impact of culturally relevant books, thereby supporting the efficacy of the JCSF.

LITERATURE REVIEW

Science Identity

Research indicates that children begin developing STEM-related career aspirations as early as elementary school (Moote et al., 2020). During this time, children shape their personal identities and develop concepts about their present and future identities, including STEM identities. Brown (2004) indicated that an individual's desire to become a STEM person influences their science identity, which is further impacted by the socialization of norms and discourse practices in STEM.

Students' sense of belonging and positive STEM identities can be fostered by incorporating authentic learning experiences grounded in ideas of diversity (Singer et al., 2020). However, the quality and quantity of these experiences may be connected to students' socioeconomic status, school district, and familial and community role models (Goodman et al., 2012; Jetten et al., 2017; Shin et al., 2016; Vekiri, 2010), creating additional barriers for groups from lower socioeconomic backgrounds or underrepresented racial and ethnic identities in STEM.

In addition to learning experiences, family, community, and prominent role models influence how children view their potential careers (Hutton, 2019; Shin et al., 2016). Nadelson et al. (2017) believed it was important to determine how much students believed their attributes, skills, and knowledge matched those of a highly identified professional. This is essential when people have stereotypes about groups, e.g., scientists are White males, generally with glasses (Starr, 2018).

Students from underrepresented groups may be more likely to struggle with their sense of belonging within the scientific community (Carlone & Johnson, 2007). To overcome these barriers, Carlone and Johnson established that individuals must feel 1) capable of acquiring scientific knowledge (i.e., competence), 2) able to demonstrate their science skills (i.e., performance), and 3) their competence and performance are acknowledged in the scientific community (i.e., recognition) in developing a strong science identity.

Most research on STEM diversification focuses on higher education and secondary students (e.g., Blanchard et al., 2023; Gutierrez et al., 2017; Morales-Doyle, 2017). This gap in the literature leaves the critical population of young children unassessed. To support younger students, especially those from underrepresented backgrounds, it is vital to gain additional knowledge about how best to support their learning and identity development in STEM.

A mechanism to address STEM identity in underrepresented groups is culturally relevant practices. Components of these theories build on justice-centered pedagogy and address deficits in identity, educational experiences, self-efficacy, and community. Gaining insight into pathways (e.g., community-based events and informal education activities) and practices (e.g., culturally relevant books and inquiry-based activities) that foster identity development among underrepresented groups will contribute to greater diversity in STEM.

Culturally Relevant Practices

Culturally relevant and critical pedagogies were used to develop a justice-centered science pedagogy (Morales-Doyle, 2017) to address inequities in science education and potentially lead to social transformation. Drawing upon the work of Ladson-Billings (1995), culturally relevant pedagogy requires students to 1) experience academic success, 2) develop cultural competence, and 3) build critical consciousness, challenging the current social order. Freire's work on critical pedagogy aligns with the framework's third criterion: a process by which people come to see themselves as capable of eliminating oppression by transforming reality (Freire, 2020, 2021a, 2021b; Freire & Macedo, 2005).

Building on these theories, Morales-Doyle's (2017) study with high school students found that students' academic achievement was supported by a curriculum organized around environmental racism. Within this framework, students can position themselves as transformative intellectuals who engage in complex thinking about science and social justice. This allows students to develop a commitment to their community and grow in credibility as knowledgeable in science. The current study was designed through the lens of a Justice-centered STEM Framework (JCSF) in Figure 1, based on Morales-Doyle's (2017) work and a prior pilot study (Blanchard et al., 2025), to scaffold the project's investigations.

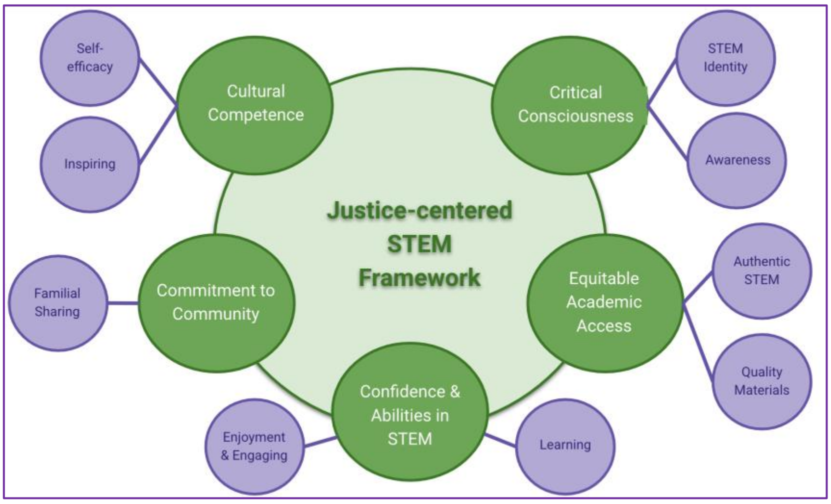

Figure 1. Justice-centered STEM Framework
(modified from Blanchard et al., 2025, and Morales-Doyle, 2017)

RESEARCH METHOD

Built on pilot work conducted with rural middle school students (Blanchard et al., 2025), the current study extends academic activities into informal educational environments. The project included two phases: STEM Family Nights and Science, Technology, Engineering, Art, and Math (STEAM) class at Kids University. During the STEM Family Nights, students received a culturally relevant book at a community event at the Dr. Paulette P. Harris Literacy Center. Students also had the opportunity to engage in STEM activities and receive culturally relevant books through participating in the Kids University summer program at Augusta University. One aim of the project was to add books to participants' family libraries, increasing access to siblings, parents, and other relatives.

Surveys were associated with each phase of the project. IRB approval was obtained to collect survey data through community events at the Harris Literacy Center (IRB#: 2234808) and at the Kids University summer program (IRB#: 2296940). Inside the front cover of the book, a half-sheet of paper was inserted that explained the purpose of the study and included web links and QR codes for the Qualtrics surveys (www.qualtrics.com). While passing out books, the researchers showed patrons of both events the paper, verbally explained the study's purpose, and asked them to participate if interested.

The patrons of both events took the books home and completed the surveys there. Convenience sampling was used, as participants at two informal education opportunities were invited to complete the surveys, including patrons of the Harris Literacy Center and the Augusta Locally Grown Farmers Market, as well as students who attended the Kids University summer program. Regardless of study participation, individuals could receive culturally relevant books to add to their family libraries and were offered the opportunity to engage in inquiry-based STEM activities.

Using a mixed-methods design, the current project aimed to promote meaningful discussions about diversity, equity, and inclusion in STEM by increasing students' awareness of and interest in STEM activities, professionals, and fields through informal educational opportunities. Using a cross-sectional sample, the project employed a convergent parallel approach, administering Likert-scale survey items (quantitative components) and open-response questions (qualitative components) to project participants. The quantitative and qualitative data were collected simultaneously, analyzed separately, and then merged to determine the project's overall findings.

Data were collected via the Qualtrics platform and analyzed in Excel. Given the small sample size, reliability testing was not conducted in the current study. The Likert-scaled items, or quantitative data, were analyzed by calculating item means for the Culturally Relevant STEM survey and subscale means for the STEM Identity survey. Further analyses were conducted with *t*-tests to compare means between the two phases of the study for the Culturally Relevant STEM survey. Other *t*-tests were used to analyze potential differences in subscale scores for the STEM Identity survey for the summer program.

The open-response items were analyzed using thematic analysis (Terry et al., 2017), with a priori themes based on the JCSF constructs: *enjoyment and engagement*, *learning*, *commitment to community*, *inspiring*, *STEM identity*, *awareness*, and *self-efficacy*. The qualitative responses were analyzed by frequency, allowing comparison between the two phases in the types of themes respondents discussed, as well as between groups in frequency differences for a single theme. The quantitative and qualitative findings were integrated to gain a deeper understanding of the project's impact on components of the JCSF and STEM Identity.

A primary goal of the project was to engage local families in STEM activities, and the decision was made to make study participation voluntary to avoid discouraging individuals from participating in the activities or taking the books home. However, the lower-than-expected response rate was a consequence of this decision, which has impacted the depth of analysis available for this project.

The voluntary nature of participation resulted in lower-than-expected response rates for the Harris Literacy Center and STEM Family Night (N = 9) and the Kids University summer program (N = 21). It was estimated that over 200 individuals attended the STEM Family Night, and 178 children attended Kids University, resulting in participation rates of 5% and 12%, respectively. This does not account for the families who visited the literacy center during the Spring of 2024 for academic support.

Phase I: STEM Family Night

The STEM Family Night was an activity organized in conjunction with Augusta University's College of Education and Human Development, Harris Literacy Center, and Augusta Locally Grown. On a monthly basis, Augusta Locally Grown hosts a farmer's market in the late afternoon. The market includes local items, such as mushrooms, strawberries, and jellies, as well as specialty items, including coconut milk and desserts. On an afternoon in late April, undergraduate students in a preservice elementary education pathway joined the market. The students were taking a content-based science course as part of their degree progression, and their contributions to the market were interactive, science fair-style activities for the community.

The college students were enrolled in two courses, one life-science-based and the other physical-science-based. The students were tasked with applying concepts from their college courses to develop an engaging activity for families to participate in. Examples of activities included creating harmonicas with popsicle sticks, active pumping heart models, plate tectonic puzzles, and Alka-Seltzer rockets. Students worked in groups to design their projects, brought them to the literacy center for the duration of the farmer's market, and engaged with the community during the event (Figure 2). The students' development, participation, and subsequent classroom presentation on the event counted as a major project grade in their college course.

The students responded positively to the project; during their class presentations, many shared that it was a wonderful learning opportunity. A student in the physical science class commented,

> *"STEM Family Night was such a wonderful experience. We were able to practice real-world applications with our projects and experience firsthand how these experiments would work with a specific age group. I am a big supporter of hands-on learning, and this was the perfect opportunity to do so. We not only had to come up with an experiment that applied to a certain curriculum but also had the chance to observe how children would interact with it."*
> *- Preservice Elementary Undergraduate Student*

Another student in the life science course commented, "*The Family STEM Night was an excellent way to meet local children and parents in the community. It was a great opportunity to get hands-on experience with the lesson we had prepared to see how it would work with children actually participating.*" The positive experience was shared by another life science student when they commented,

> *"My major is pre-elementary education, and I will be teaching young children in the future. I thought the STEM Family Night was a fun and engaging opportunity to help kids engage with science and other things. It was great to see families working together and to see the students become truly excited to be learning." - Preservice Elementary Undergraduate Student*

Figure 2. Undergraduate preservice elementary teachers at STEM Family Night.
Note: Top Left: Popsicle Stick Harmonicas; Top Right: Exploring Microscopes; Bottom Left: Volcanoes: The Ring of Fire and Chemical Reaction with Lava Lamps; Bottom Right: Alka-Seltzer Rockets.

In addition to the STEM activities, there was a table where patrons could grab a cookie and a bottle of water at no cost and take home a culturally relevant STEM book (Figure 3). The books were short biographic-style stories about underrepresented individuals in STEM. They were written at the elementary reading level and filled with colorful images. At this event, two books were shared with patrons: *Hidden Figures,* by Margot Lee Shetterly and Winifred Conkling, and *The Boy Who Harnessed the Wind,* by William Kamkwamba and Bryan Mealer. A half-sheet of paper was placed inside the books, requesting that individuals use the included web link or QR code to access the Culturally Relevant STEM survey.

Figure 3. Sharing Culturally Relevant STEM Books with the Local Augusta Community.
Note: Left: Book Display at Harris Literacy Center; Right: Books & A Cookie Table at STEM Family Night.

Throughout the Spring semester, six culturally relevant, STEM-focused books were found outside the Harris Literacy Center (Figure 3). The books were placed on small bookstands, accompanied by a flyer explaining their purpose and encouraging patrons of the literacy center to take them home. Frequently, the first author would sit with the books in the afternoon, personally inviting patrons to take the books home to share with their families. As with the STEM family night, a small paper was placed inside the books, requesting individuals to participate in the Culturally Relevant STEM survey.

Phase II: STEAM Classes at Kids University

Local children enrolled in the Kids University program at Augusta University in June. The program spanned four weeks, lasting from 8:30 am to 4:50 pm, Monday through Friday. There were 178 children who participated in the summer program, with some attending only one week and others attending all four weeks. Some children attended only half days, whereas others signed up for full-day participation. Participation varied depending on parental choice.

The program had a reasonable participation fee that covered the necessary supplies for classroom activities and the wages of the teachers and paraprofessionals. Most teachers and paraprofessionals working in the summer program also worked in the local schools. The program included a variety of classes for children, including Drama, Art, Entomology, Reading, Physical Education, Yoga, and STEAM. Participants were students in grades K-8, generally from the surrounding area.

Students attended a STEAM class daily with students of similar grades and ages. The STEAM class incorporated weekly project-based learning and inquiry-based activities organized by theme. Students also received culturally relevant, age-appropriate books related to weekly topics. Students were invited to participate in two surveys: 1) Culturally Relevant STEM and 2) STEM Identity. The survey data were collected weekly from students, and a reminder email was sent to parents on the Monday following participation. The data were evaluated to measure the influence of informal learning opportunities on students' STEM identity.

The STEAM course was structured around project-based learning, with each week featuring a theme and a probing question (Table 1). The learning goals for that week were paired with activities and inquiry-based projects. Students were given culturally relevant books to add to their family libraries, supporting the week's topic. The elementary students (Grades K-5) were given nonfiction books that shared true stories of people who made outstanding contributions in STEM.

These individuals often do not fit the stereotypes portrayed in the STEM field but have made extraordinary advancements. The books selected for middle school students (Grades 6-8) were fictional works that reflected important aspects of STEM through the lens of Cli-Fi, or climate fiction. This genre of books focuses on stories in which climate change is a central plot element. It portrays events that may occur in society and the environment as a result of human activity.

Table 1. Outline of Topics for STEAM Classes Summer 2025

Topic	Probing Question	Elementary School Book	Middle School Book	Major Project
Food Science	How do we keep our food safe?	*Farmer Will Allen and the Growing Table* (Martin et al., 2013)	*Fairhaven: A Novel of Climate Optimism* (Willis & Lee, 2024)	GLO Germ Kits
Physical Science	How do the laws of physics impact our safety?	*Starstruck: The Cosmic Journey of Neil deGrasse Tyson* (Krull et al., 2021)	*Haven Jacobs Saves the Planet* (Dee, 2023)	Egg Drop

Space Science	How can space science impact our lives?	*Hidden Figures* (Shetterly & Conkling, 2018)	*A Snake Falls to Earth* (Little Badger, 2024)	Balloon Rocket
Environmental Science	How can we take care of our environment?	*The Boy Who Harnessed the Wind* (Kamkwamba & Mealer, 2021)	*Imaginary Borders* (Martinez, 2020)	Water Filtration

The STEAM course was designed to identify the most pressing problem in the local, state, or global communities. Students worked collaboratively to solve those problems through science, math, art, technology, and engineering concepts. Purpose-driven inquiry was used to scaffold students' development of a better understanding of the agency they can have as individuals to impact their community. These activities provided students with opportunities to engage in inquiry-based learning that presented concerns relevant to their community, e.g., clean water, food safety, and sustainable energy (Figure 4).

The first week focused on food safety and began with a Glo Germ activity in which students experimented with a luminescent material visible under black light (Home Science Tools, n.d.). This illustrated how easily germs are transmitted while reinforcing the importance of handwashing. This week included an activity in which food dye was added to milk, and dish soap was used to disperse the dye due to differences in polarity (Perot Museum, n.d.). This lab activity not only provided a brief lesson on polarity but also demonstrated how soap cleans materials. The first week also included an activity in which students made ice cream in plastic bags, providing an opportunity to discuss melting points and food preservation (Girl Scouts National Capital, n.d.).

Figure 4. Kids University Participants engaging in STEAM Activities.
Note: Top Left: Egg Drop; Top Right: Ice Cream in a Bag;
Bottom Left: Oil Spill Cleanup; Bottom Right: Balloon Rockets.

The second week focused on physical science concepts, culminating in an egg drop experiment (e.g., The Institution of Engineering and Technology, n.d.; McClelland, 2025b). Over a couple of days, students worked in pairs to construct an apparatus to protect their egg using small cardboard boxes, paper, bubble wrap, and other packing materials. Drop trials were conducted first with plastic eggs to allow students to refine their designs, and the following day, they progressed to real eggs. On Friday of that week, students engaged in authentic experimentation, dropping their eggs from the university stairwell at the first-, second-, and third-floor landings.

The third week focused on space science, and the students began the week with agility trials on a simple obstacle course and a discussion of the necessity of physical fitness for astronauts (NASA, 2024a). Students created constellations using cardboard tubes and black paper (Durham, 2020) and built a rocket using a balloon, a straw, and a string (NASA, 2024c). This week culminated in the students developing a rocket propelled by Alka-Seltzer tablets and a small bottle, such as an empty medicine bottle or a film canister (Purdue University, 2020).

During the last week, students focused on environmental science, and they discussed the importance of clean water. As part of the weekly activities, students simulated an oil spill in a small metal pan (Vivify STEM Education, 2016) and then cleaned it up. Students also created seed bombs to take home and plant (McClelland, 2025a) and developed a straw-and-cup windmill to demonstrate green energy (Dingler, 2024). Lastly, students designed a basic water filtration device with household materials (e.g., sand, washed charcoal, and aquarium gravel) and a plastic funnel, which they used to clean simulated dirty water (NASA, 2024b).

Surveys

STEM Identity Survey

The STEM Identity survey is geared toward elementary school-aged children and is based on the Role Identity Survey in Engineering (RIS-E; Paul et al., 2020). The items in the original survey, which focused on engineering identity, were modified to inquire about a more general STEM context, RIS-STEM. The modified survey, RIS-STEM, was validated with 678 fourth- and fifth-grade students through Confirmatory Factor Analysis (CFA) and Item Response Theory (IRT) in prior research (Paul et al., 2020).

The analyses yielded reliable scores measuring aspects of identity: competence, interest, self-recognition, and recognition by others. Items from the RIS-E and RIS-STEM were used to develop the STEM Identity survey for the current project (Table 2). The STEM Identity survey uses a 4-point Likert scale, with 1 representing *No!*, 2 portraying *no*, 3 for *yes*, and 4 denoting *Yes!* The survey was used with children who attended the Kids University program to gauge the impact of the activities and materials on students' STEM identity.

Table 2. STEM Identity Survey

Scale	Survey Item
Recognition by Others	I am a STEM person.
	My family thinks of me as a STEM person.
	My friends think of me as a STEM person.
	My teachers think of me as a STEM person.
Interest	After a really interesting STEM activity, I look for more information about it.
	I need to know how objects work.
	I want to read everything I can find about STEM.
	I want to know everything about STEM.
Self-recognition	I want to know how to do everything that people in STEM do.
	Knowing STEM concepts is important.

	Knowing STEM concepts helps me understand how the world works.
	Thinking like a STEM person will help me succeed in the future.
Competence	I think I am very good at figuring out how to fix a STEM activity that didn't work.
	I think I am very good at coming up with STEM-related questions.
	I think I am very good at doing experiments.
Open Response	What did you like best about your STEM class?
	Is there anything else you would like to share?

Culturally Relevant STEM Survey

The survey prompts for the Culturally Relevant STEM Survey (Table 3) were developed in a prior research project (Blanchard et al., 2025) and are based on constructs of the modified Morales-Doyle (2017) framework in Figure 1. Before initial distribution in prior work (Blanchard et al., 2025), the survey items were shared with other science educators (i.e., faculty and graduate students) and middle school students to provide face and content validity (Sartori & Pasini, 2007). In Qualtrics, survey questions used a 5-point Likert scale, with 1 indicating *strongly disagree* and 5 indicating *strongly agree*. The prior project linked these items to facets of the justice-centered framework (Table 3; Blanchard et al., 2025).

Table 3. Culturally Relevant STEM Survey

Justice-centered Construct	Book Items
Critical Consciousness	Q1: Sometimes doing what is right, or ethical, is difficult.
Commitment to Community	Q2: Others in the community were impacted by the abilities of the main character. Q3: The main character was committed to making their community a better place. Q5: This story made me believe I can impact my community in a positive way. Q7: I shared the book with a friend or a family member.
Confidence & Ability in STEM	Q4: This story made me believe that if I wanted to, I could have a career in STEM (science, technology, engineering, or math).
Equitable Access to Materials	Q6: I read the whole book.
Cultural Competence	Q8: This book is an example of how STEM can change the culture or habits of one's community.
Open Response	Q9: Did the book make you think differently about anything in your life? Explain.

FINDINGS AND DISCUSSION

Culturally Relevant STEM at the Harris Literacy Center

Culturally relevant books with a STEM focus were available at the Harris Literacy Center throughout the Spring semester and were shared with patrons of the STEM Family Night in late April. The two events accounted for more than 800 books being distributed to community members, including children, adolescents, and adults. However, the survey response rate was quite low.

A total of sixteen surveys were begun, with nine being completed. The participants included an elementary-aged child (n = 1), adolescents (n = 3), and adults (n = 5). The responses spanned all the books distributed at the literacy center. Seventy-eight percent of the participants identified as Black, Indigenous, or Other People of Color (BIPOC). Thirty-three percent of participants had a parent or guardian with a master's or professional degree.

Survey items were scored on a 5-point Likert scale, and items were worded such that higher scores represented a strong alignment with the JCSF (Table 4). The average score across three items exceeded 4, indicating agreement with the framework. This included Q2 (M = 4.33, SD = 0.71), Q3 (M = 4.33, SD = 0.87), and Q6 (M = 4.11, SD = 0.78). Two items reflected *commitment to community*, Q2 and Q3, whereas Q6 represented *equitable access to materials*. Four items reflected scores between 3 and 4, representing a more neutral disposition. These items include Q4 (*confidence and ability in STEM*; M = 3.33, SD = 0.71), Q5 (*commitment to community*; M = 3.89, SD = 0.78), Q7 (*commitment to community*; M = 3.67, SD = 0.87), and Q8 (*cultural competence*; M = 3.67, SD = 1.22).

One item had a mean below 3, indicating disagreement: Q1 (*critical consciousness*; M = 2.89; SD = 1.05). The mean across all items was 3.79 (SD = 0.92), indicating a score slightly below agree. It was hypothesized that the scores would align with constructs of JCSF (H2). For many items, this occurred (i.e., Q2, Q3, and Q6). However, one group of scores was lower than expected (i.e., Q1), indicating some disagreement with the construct of *critical consciousness*. Given the small sample size, the findings cannot be generalized to larger populations.

The survey also included an open-response item: "*Did the book make you think differently about anything in your life? Explain.*", for which most participants responded with a comment (77%; n = 7). Most comments were assigned a single code based on participants' statements. If the comments contained multiple ideas, the comments were broken into units, and each segment was coded as a separate idea, a process called unitization (Campbell et al., 2013). The first and second authors independently coded all statements, and initial agreement was 60%. All codes with discrepancies were reviewed, and codes were reassigned until 100% agreement was reached between the two coders.

Several comments reflected components of the JCSF. A 69-year-old White female expressed *self-efficacy* with "*[the book] reinforced the idea that people can achieve more than they think possible*" after reading *Starstruck* (Krull et al., 2021). After reading *Farmer Will Allen and the Growing Table* (Martin et al., 2013), a 35-year-old, Multiracial female stated that "*Growing food helps communities and families eat and survive; teaches them skills*," reinforcing the theme of *commitment to community*.

Awareness was demonstrated by the statement, "*How much music can change people's lives*" (18-year-old, African American female), whereas the statement, "*Yes, to believe*," reflected the *inspiring* nature of the books (62-year-old, Hispanic female). "*The importance of critical thinking and observation*" was a comment from a 59-year-old Multiracial female, demonstrating the concept of *authentic STEM*. Collectively, the comments shared by patrons of the literacy center support the components of the JCSF as hypothesized (H3).

Culturally Relevant STEM at Kids University

Nineteen students participated in the Culturally Relevant STEM survey through the Kids University program. Forty-seven percent of the students who participated had attended the program for 1 week, whereas 32% had attended for at least 3 weeks. Only 1 student reported participating in all 4 weeks (5%). Most of the students were female (63%) and ranged in age from 5 to 8 years (89%). A diverse mix of racial and ethnic groups completed the survey, including students who identified as African American (11%), Asian (32%), Middle Eastern (11%), and White (26%). Twenty-one percent of participants chose not to identify their racial or ethnic group.

Most participants reported that their parents had either a master's degree (42%) or a professional degree (32%). The most common book students reported reading was *Starstruck: The*

Cosmic Journey of Neil deGrasse Tyson (37%; Krull et al., 2021), followed by *Farmer Will Allen and the Growing Table* (26%; Martin et al., 2013). An equal number of students reported reading *Hidden Figures* (16%; Shetterly & Conkling, 2018) and *The Boy Who Harnessed the Wind* (16%; Kamkwamba & Mealer, 2012). No surveys were completed for the middle school-aged books.

Mean scores were computed for the survey items, with higher scores indicating greater alignment with the JCSF constructs. Seven of the eight items had mean scores above 4, ranging from 4.3 to 4.6 (Table 4), indicating responses ranging from agree to strongly agree. These findings support the hypothesis that participants' scores would align with the JCSF (H2).

The mean survey score for this iteration was 4.32 (SD = 0.87) out of 5.00, indicating agreement with the framework. One item has a mean score closer to a neutral response (Q1; M = 3.42; SD = 1.39), "*Sometimes doing what is right, or ethical, is difficult.*" This item was aligned with *critical consciousness* in prior research (Blanchard et al., 2025) and was the lowest-scoring item among respondents at the literacy center.

Additional analyses were conducted to compare the means of the culturally relevant survey responses between the summer program and the literacy center. The Welch's t-test, a two-tailed t-test assuming unequal variance, was selected due to the unequal sample sizes. An alpha level of 0.05 was selected, and the tests were conducted in Excel. The total survey mean for the summer program (M = 4.32; SD = 0.87) was significantly higher (p = 0.000) than that of individuals who attended STEM Family Night and the Harris Literacy Center (M = 3.79, SD = 0.92). These results indicate that those who attended the summer program reported responses that were more aligned with the JCSF than those at the literacy center.

Analyses were also conducted for individual survey items across the programs, identifying one significant difference. Individuals who attended the Kids University program reported significantly higher scores (M = 4.63; SD = 0.50; p = 0.000) for *confidence and abilities in STEM* (Q4) than those you visit the Harris Literacy Center and STEM Family Night (M = 3.33; SD = 0.71). Other tests revealed insignificant differences (p > 0.05). These findings partially support the second hypothesis that scores would be similar across the project phases.

Table 4. Welch's t-test between Programs for Culturally Relevant STEM Survey

Item: Justice Centered Construct	**Kids University (N = 19)**		**Literacy Center (N = 9)**				
	M	***SD***	***M***	***SD***	***df***	***t***	***p***
Q1: Critical Consciousness	3.42	1.39	2.89	1.05	20	1.12	0.275
Q2: Commitment to Community	4.53	0.61	4.33	0.71	14	0.70	0.493
Q3: Commitment to Community	4.42	0.51	4.33	0.87	11	0.28	0.783
Q4: Confidence & Ability in STEM	4.63	0.50	3.33	0.71	12	4.96	0.000*
Q5: Commitment to Community	4.42	0.84	3.89	0.78	17	1.64	0.119
Q6: Equitable Access to Materials	4.63	0.60	4.11	0.78	13	1.77	0.101
Q7: Commitment to Community	4.26	0.87	3.67	0.87	16	1.70	0.109
Q8: Cultural Competence	4.26	0.81	3.67	1.22	11	1.33	0.210
All Items	4.32	0.87	3.79	0.92	135	4.07	0.000*

Note: Based on a 5-point Likert Scale; M symbolizes mean; SD is an abbreviation for standard deviation; df represents degrees of freedom; and * denotes a p-value indicating significant difference ($p < 0.05$).

The open-response item, "*Did the book make you think differently about anything in your life?*", was coded based on themes associated with the JCSF. Of the nineteen students who participated in the survey, fourteen students left comments (74%). The mechanisms described in the previous section for co-coding were repeated for this set of statements. The initial agreement was 74%; discrepancies were discussed until the coders reached 100% agreement. A total of nineteen codes were assigned to the fourteen statements (Table 5).

Table 5. Exemplar Comments from Culturally Relevant STEM Survey

Theme	Definition	Quote
Enjoyment & Engagement	Students share positive experiences regarding the book and/or activities.	*"I liked reading the book."* (7-year-old, Asian female, *Farmer Will Allen*)
Learning	Students comment on newfound knowledge gained in the STEAM class or books.	*"I learned you can grow your own food and use the wriggly worms."* (7-year-old, Asian female, *Farmer Will Allen*)
Commitment to Community	Students speak about contributing positively to their community.	*"I can help my community."* (7-year-old female, *Farmer Will Allen*)
Inspiring	Students express positive intentions for their future, stemming from their experiences in the STEAM class or from the books.	*"Follow your dreams and work hard to achieve them."* (no demographic information, *Starstruck*)
STEM Identity	Students comment on their potential role in the STEM field.	*"I would love to be a scientist too."* (5-year-old, Asian, female, *Starstruck*)
Awareness	Students address difficult circumstances faced by underserved individuals in STEM.	*"It made me surprised by the hard work that this scientist did to get to his goal."* (8-year-old, Middle Eastern female, *Starstruck*)
Self-efficacy	Students speak about their belief in their ability to succeed in future situations or tasks.	*"...by hard work, I can make a difference in the world."* (8-year-old, Middle Eastern female, *The Boy Who Harnessed the Wind*)

The most frequent codes used were *commitment to community* (21%) and *inspiring* (21%), followed by *STEM identity* (16%) and *learning* (16%). Other components of the framework used in coding included *enjoyment and engagement* (10.5%), *learning* (16%), *awareness* (10.5%), and *self-efficacy* (5%). An example of a statement reflecting *commitment to community* was, "*We should grow a bigger garden*," (5-year-old, White male; *Farmer Will Allen;* Martin et al., 2013).

STEM identity was represented by a 5-year-old, Asian female who declared, "*I would love to be a scientist too*," after reading *Starstruck*. *Self-efficacy* was exemplified by an 8-year-old Middle Eastern female who reported, "*...by hard work, I can make a difference in the world*," after reading *The Boy Who Harnessed the Wind.* The comments reflected a positive impact of the books on the students who read them and indicated alignment with the JCSF, supporting the third hypothesis.

STEM Identity at Kids University

Twenty-one students participated in the STEM Identity survey through the Kids University program. Approximately equal numbers of students had attended the program for one week (29%), two weeks (33%), or four weeks (33%). Only one student reported they had attended three weeks (5%). Parental education showed an upward trend in degree attainment: associate's (10%), bachelor's (20%), master's (25%), and professional (45%). The majority of the participant sample was female (71%), and there was a variety of racial and ethnic identities in the participant group, including Asian (38%), White (24%), African American (14%), Middle Eastern (10%), and Multiracial (10%). One participant did not disclose their identity (5%).

Based on previously validated survey analysis (Paul et al., 2020), the abbreviated survey used the pre-established subscales to group the survey items (Table 2). The survey responses were scored on a 4-point Likert scale, with higher scores reflecting a stronger STEM identity and lower scores indicating a deficit in STEM Identity. The overall survey mean was 3.50 (*SD* = 0.64) out of 4.00, indicating strong support for a STEM Identity among Kids University participants.

The composite means for each construct were also calculated by averaging the subscale questions (Table 6). The highest mean was observed for *recognition by others* (*M* = 3.62; *SD* = 0.60) and for *self-recognition* (*M* = 3.55; *SD* = 0.59). The remaining subscales' scores also supported evidence of students' STEM identity, including *competence* (*M* = 3.42; *SD* = 0.67) and *interest* (*M* = 3.41; *SD* = 0.69). The scores indicate an inspiring learning environment that students experienced during the summer program, highlighting recognition from peers and teachers, supporting the second hypothesis.

The Welch's *t*-test, a two-tailed *t*-test assuming unequal variance, was selected to compare the means across the subscales of the STEM Identity survey. An alpha of 0.05 was selected for these tests, and analyses were conducted in Excel. The analyses yielded one significant difference: the mean score for the *interest* subscale is significantly lower than that for *recognition by others* (p = 0.042). The other paired *t*-tests had *p*-values greater than 0.05; therefore, their means were not significantly different, partially supporting the hypothesis (H2).

Table 6. Welch's *t*-test Comparing the STEM Identity Survey Subscales

	Variable 1 (V1)		**Variable 2 (V2)**				
	M	**σ^2**	***M***	**σ^2**	***df***	***t***	***p***
V1: Recognition by Others V2: Interest	3.62	0.36	3.41	0.47	157	2.05	0.042*
V1: Recognition by Others V2: Self-recognition	3.62	0.36	3.55	0.35	162	0.74	0.460
V1: Interest V2: Self-recognition	3.41	0.47	3.55	0.35	155	-1.35	0.178
V1: Recognition by Others V2: Competence	3.62	0.36	3.42	0.46	115	1.78	0.077
V1: Interest V2: Competence	3.41	0.47	3.42	0.46	126	-0.10	0.924
V1: Self-recognition V2: Competence	3.55	0.35	3.42	0.46	115	1.15	0.254

Note: Based on a 4-point Likert Scale; *M* symbolizes mean; σ^2 is an abbreviation for variance; *df* represents degrees of freedom; and * denotes a *p*-value indicating significant difference ($p < 0.05$).

At the end of the STEM Identity survey, participants could respond to two items: 1) What did you like best about your STEM class?, and 2) Is there anything else you would like to share? The responses to these items were coded using the same mechanism as in the culturally relevant survey, based on the JCSF components. The initial agreement was 52%; the co-coders discussed discrepancies until reaching 100% agreement.

A total of twenty-seven units were coded within the twenty-four comments provided. The most frequent theme identified in the students' comments was *authentic STEM* (33%), followed by *enjoyment and engagement* (30%). *Learning* appeared in 15% of the statements, whereas *commitment to community* and *STEM identity* each appeared in 11% of the comments. Overall, the comments reflected a positive learning environment, engaging activities, and the development of a learning community between students and teachers, supporting the third hypothesis.

Commitment to community was a theme that revealed the learning community developed among peers and the teacher during the summer program. Reflecting this concept, a 10-year-old Asian male stated, "*[I am] grateful to the teachers and student partners*." *Authentic STEM* was represented by an 8-year-old Middle Eastern female who expressed she liked "*the experiments after they work, especially the egg drop one*."

Students expressed thoughts related to *enjoyment and engagement* with the activities, as seen in a comment by a 10-year-old Asian male stating, "*I like the projects. They were fun*." An 8-year-old African American female reflected on the *learning* experience, commenting, "*that there are...so many learning opportunities*." *STEM identity* was also seen in a 10-year-old White male's comment, "*[I] like science and everything related to it.*" These comments reflect positive alignment with the JCSF and the quality of students' experiences during the STEAM course, as hypothesized (H3).

Discussion

This mixed-methods study focused on engaging the community through STEM activities in informal educational settings. The Harris Literacy Center is a community resource that provides literacy support for children, adolescents, and adults. This location was used for this project as a venue to bring the community together and share culturally relevant literature. This facility also hosted the STEM Family Night, where families could engage in STEM activities and receive children's books with a culturally relevant STEM focus. Kids University is a cross-curricular, academic-based summer program for children in grades K-8 in the Augusta region. The program is based at Augusta University in the College of Education and Human Development. Children had the opportunity to participate in STEM activities during the STEAM class and receive culturally relevant books to add to their families' libraries. Similar informal education programs have shown positive success at addressing inequities in STEM experiences (e.g., Blanchard et al., 2023; Gutierrez et al., 2017; Stringer et al., 2019).

RQ 1: Project Participation

Over 1,000 culturally relevant STEM books were shared with community members through the Harris Literacy Center, STEM Family Night, and the Kids University summer program. Though participation in the surveys was scarce, engagement with the STEM activities and excitement toward the books were high at both venues. Therefore, the data reflects the research participation more than engagement in the project.

It was hypothesized that survey completion rates would be higher among summer program participants than among the literacy center participants (H1). As the summer program had previously been connected to research projects, it was thought that those who attended in prior years might be more familiar with research studies and, consequently, more inclined to participate. The differences in survey completion rates support this hypothesis, revealing more participants and higher participation rates for the summer program than the literacy center.

An interview-based study was conducted by the American Institutes for Research (AIR) to gain insight into why individuals choose not to respond to surveys (Medway, 2022). Several reasons were identified as to why surveys were not frequently completed, including 1) privacy concerns, 2) anti-government sentiment, 3) lack of time or energy, 4) survey length or difficulty, 5) lack of interest, and 6) lack of civic/community engagement. Researchers in the prior study suggested the following mechanisms to improve response rates: confirm legitimacy, revise messaging, redesign the survey, improve visual appeal, and add a sense of urgency.

A contrast between the two phases of the project lies in the descriptive statistics. For the STEM Family Night, most participants were BIPOC (78%), whereas those who attended the summer program were predominantly Asian and White (58%). Parental education attainment was another area of difference between the two phases, with the literacy center having 33% of parents having a master's or professional degree, compared with 74% in the summer program. Because many of the parents of the summer program held advanced degrees, they were likely more familiar with research and therefore more inclined to participate.

Although the Kids University participants were more engaged in completing the surveys, there were no responses from the middle-school-aged students. Middle school students received novel-style books to take home, which would have taken considerably more time to read than the picture-style books shared with the elementary-aged students. In addition, the summer program ran from 8:00-5:00 pm each day, limiting the potential reading time to mornings and nights. Selecting shorter books that were still at the appropriate reading level could have encouraged greater participation in middle school students.

RQ 2: Analysis of Survey Results between Groups and Survey Constructs

The second research question examined the relationship between participants' Likert-scale survey responses and the JCSF. Survey responses supported the hypothesis for alignment with the JCSF and STEM Identity. However, significant differences in survey responses were identified between the two programs, and consequently, only partially support the hypothesis of similarity between groups (H2).

The survey results reveal the importance of quality materials and community in both groups. Of the Culturally Relevant STEM surveys completed at the Harris Literacy Center and STEM Family Night, the mean scores aligned with the components of the JCSF, with *commitment to community* and *equitable access to materials* receiving the highest scores. Students at Kids University reported the highest scores for *confidence and abilities in STEM, commitment to community,* and *equitable access to materials*. The item relating to *critical consciousness* (Q1) received the lowest scores in both groups. As the selected books were designed for elementary-level readers, they may not have reflected the construct of *critical consciousness* as well as books on more complex topics might. As seen in the current study, prior research supports the use of culturally relevant literature with students from underserved groups (e.g., Guha, 2025; Kolovou, 2023).

Analysis of STEM Identity means scores supports concepts related to STEM identity among Kids University participants, with an overall survey mean of 3.50 out of 4.00. The composite means for each construct were also high, ranging from 3.41 to 3.60. Based on *t*-tests, one significant difference was identified with the STEM Identity Survey for the Kids University participants. The mean score for *recognition by others* was significantly higher than *interest*. Collectively, the responses reflected a positive learning environment, engaging activities, and the development of a learning community between students and teachers during the STEAM class.

As both groups engaged in similar inquiry-based activities and received the same books, it was not expected that their survey responses would differ significantly. The results of *t*-tests indicated that summer program participants had significantly higher overall mean scores on the Culturally Relevant STEM survey and a significantly higher item means for *confidence and abilities in STEM* than those who attended the literacy center. These findings indicate that the summer program's impact may have been greater than that of the STEM Family Night. These findings support the idea that multi-day programs connected to a defined learning environment may have a stronger impression on participants than shorter, unstructured events.

RQ 3: Connection of Open-response Items and Justice-Centered STEM Framework

The third research question sought to identify the relationships between the JCSF and the open-response items. Participation at the literacy center was substantially lower than in the summer program, but the themes identified included *self-efficacy*, *commitment to community*, *awareness*, *inspiring*, and *authentic STEM*. During the summer program, the most common themes were *commitment to community* and *inspiring,* followed by *STEM identity* and *learning*. Participant responses in both phases of the project reinforced the quantitative findings and aligned with the JCSF, supporting the hypothesis (H3).

Throughout both phases of the program, *commitment to community* was a high-scoring Likert item and a frequent theme in the open-response comments on the Culturally Relevant STEM survey. These occurrences reinforce the importance of including the community in STEM outreach activities, such as STEM Family Night. Informal education programs are invaluable opportunities to engage families in STEM learning and to help younger children develop a STEM identity. These findings are supported by prior research showing that utilizing out-of-school programs provides opportunities to reach students who may distrust the school system (Beard & Brown, 2008) and to engage family members (Zucker et al., 2024).

Due to the project's design, only students in the summer program participated in the STEM Identity survey. The analyses of Likert items yielded encouraging mean scores, with the highest mean in the *recognition by others* and *self-recognition* subscales. In contrast, *interest* and *competence* were the lowest-scoring items. The most common themes associated with the open-response portion were *authentic STEM* and *enjoyment and engagement*.

These aspects reflect the positive learning environment in the STEM classroom and the positive impact of the STEM activities incorporated into the class. The lower-scoring items provide insight for areas to address in future iterations of the project (i.e., *interest* and *competence*). As shown in previous research, the use of hands-on, inquiry-based activities has been found to cultivate students' personal scientific activity and inquiry ability, cultivate students' knowledge, and enhance students' capacity for creative thinking (Chen & Chen, 2021).

CONCLUSIONS

This project sought to engage community members in STEM activities and culturally relevant books through the local literacy center. During a second phase of this project, students attending a university-based summer program participated in inquiry-based activities and received STEM trade books to add to their family libraries. This study provides evidence that interactions with community centers and informal education events are pathways to inspire underrepresented students to engage in STEM, potentially increasing diversity in the STEM workforce.

It was hypothesized that participation would be similar across both venues, but this was not supported by the findings (H1). The survey completion rates were higher for the summer program than for the community event. The summer program has included research studies in prior years, indicating that a research culture connected to the program needs to be developed and nurtured to encourage participation.

Survey completion was low in both phases of the project and non-existent for middle school-aged students during the summer program. Though the project's purpose and execution were successful, the data collection grossly underrepresented the project's impact, leading to a loss of insight into theory and pedagogy development. For students in an all-day summer program, it may be helpful to select shorter books for middle school-aged students to make task completion easier and, consequently, increase survey completion rates. Providing incentives for survey completion, such as gift cards, may be an additional means of encouraging research participation.

As shown in this project, providing students with culturally relevant STEM-focused literature can address many facets of the JCSF, including *STEM identity, commitment to community, authentic STEM, self-efficacy, inspiring,* and *enjoyment and engagement*. The framework's support was evident in the Likert-scale survey items and open-ended comments, supporting the second and third hypotheses.

Higher mean scores on the Culturally Relevant STEM survey for the summer program indicated a greater impact, which may be attributed to differences in the programs' structure and length. The findings of the current study support the positive impact of culturally relevant literature on all students, especially underrepresented groups, consistent with prior studies (e.g., Guha, 2025; Kolovou, 2023).

The incorporation of hands-on, inquiry-based learning was a critical component of both phases of this project. These activities further supported student participation in STEM by offering *authentic STEM experiences* that foster *enjoyment and engagement,* positively impacting students' *STEM identity*. As seen in participants' survey responses, inquiry-based activities cultivated STEM identity and aligned with the JCSF, supporting the hypothesized relationships (H2 and H3).

Both groups shared aspects of community in open-response items, indicating the importance of family and community in the development of STEM identity. These findings support incorporating authentic learning opportunities that engage families in STEM, which is especially valuable for those who lack confidence in the traditional education system (Beard & Brown, 2008; Zucker et al., 2024).

Collectively, the project supported the use of culturally relevant STEM trade books alongside inquiry-based STEM activities, as evidenced by survey responses. These findings also support the use of the JSCF to scaffold learning opportunities for elementary-aged children in informal education settings. The study's findings yield several actionable research recommendations for future projects, as shown in Table 7.

Table 7. Actionable Research Recommendations

Conclusions	Implications
Survey participation was greater during the Kids University program than during the STEM Family Night.	A research culture connected to programs needs to be developed and nurtured to encourage participation.
Materials need to be of high quality but not time-intensive.	Novellas for older readers may increase task completion and survey participation while providing materials at an appropriate reading level.
Participant engagement may not be accurately reflected in survey completion rates.	Connecting survey completion to gift cards or other incentives is a way to foster research participation.
Survey results were significantly higher for the Kids University program than for the STEM Family Night.	Multi-day programs connected to a defined learning environment may have a greater impact on participants than shorter, unstructured events.
Survey results indicated that the materials aligned with the JCSF and supported participants' STEM Identity.	Hands-on, inquiry-based STEM activities and Culturally Relevant STEM books provide opportunities for families to engage in STEM, building their STEM Identity and experiences with social justice constructs.
Community was a common theme for open-response survey items.	Including family members in informal education programs can foster greater interest

in STEM.

LIMITATION & FURTHER RESEARCH

Both phases of this project received positive responses from community members, including adults and children. Patrons at the Harris Literacy Center received books, and many responded positively to the STEM activities and books distributed during STEM Family Night. Similarly, many of the children were highly engaged in the STEM activities during the Kids University Program. However, survey response rates were minimal.

The response rate for the books at the STEM Family Night was 5%, whereas participation at Kids University was higher, at 12%. However, insights gained from the data can be interpreted only as snapshots of the project and should not be generalized to the larger group. This project was successful from an educational and community engagement perspective. However, the research data are lacking in quantity, limiting analysis. Increasing participation will be a focus in future iterations.

Future research should consider incentives to encourage participation, such as gift cards for survey completion. In the two phases of the project, a multitude of books were shared with families, who expressed appreciation and enjoyment at the events. However, this positive association did not translate into higher survey completion rates. Furthermore, a longitudinal study would be insightful for better understanding of how repeated interactions with STEM activities and culturally relevant literature impact students' STEM identity and the constructs of the JCSF.

Connecting task completion to continued participation in programs, especially through at-home activities, could provide additional motivation for students to continue. Lastly, bridging informal activities with schools could serve as a liaison between the project and the students. Teachers and/or school counselors could help identify potential students interested in the project and encourage participation if the study involved multiple iterations of activities or books.

Project-based research has two goals: 1) to provide supportive educational opportunities for participants, and 2) to gather research data to learn from the study and contribute to the literature. The current project successfully engaged community members in STEM activities and added culturally relevant books to families' libraries. However, the data collected does not reflect its impact. In designing future projects, a greater focus is needed on ensuring motivational components for participants in data collection.

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