WIP: A Two-Generation Model to Support STEM Education in Hispanic-Serving Institutions

Biao Jiang, Norberto Michel Hernandez Valdes-Portela, JungHang Lee, Sarah L. Hoiland
Hostos Community College, bjiang, nvaldes-portela, julee, shoiland@hostos.cuny.edu

***Abstract* - This innovative practice WIP paper describes a pioneering National Science Foundation-supported research project designed to address the underrepresentation of minority groups in STEM fields by meeting the educational needs of community college student parents. The Holistic Oasis for Parents' Education (HOPE) Program at Hostos Community College centers on a dual-enrollment model, wherein community college parenting students (HOPE Scholars) pursue their academic goals by taking STEM courses during the summer while their children, ranging from kindergarten through fifth grade, are engaged in enriching hands-on STEM activities on the college campus. By aligning the educational pursuits of parents and children, this program supports the academic advancement of adult learners and fosters a positive learning environment for the next generation. The Program's holistic approach empowers HOPE Scholars to accumulate summer credits in STEM courses and nurtures the STEM talent pipeline by inspiring the younger generation.**

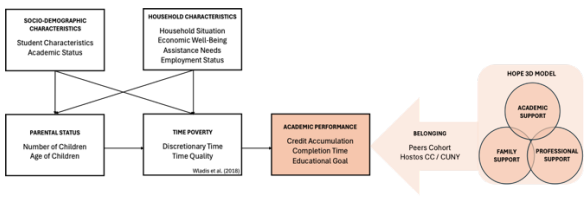
Keywords - parenting students, community colleges, holistic, two-generation (2Gen), STEM education, experiential learning.

I. Introduction

The significance of Science, Technology, Engineering, and Mathematics (STEM) education cannot be overstated in today's rapidly evolving world. STEM disciplines form the backbone of innovation, driving advancements in fields ranging from healthcare to environmental sustainability. However, despite the increasing demand for STEM professionals, there exists a persistent underrepresentation of minority students in these fields[1] [1]. The importance of STEM education for underrepresented minority students goes beyond individual career prospects; it is a matter of equity, diversity, and national progress. Historically marginalized communities, including African American, Hispanic, Native American, and other minority groups, have faced systemic barriers to accessing quality STEM education[2] [2]. This lack of representation limits the diversity of perspectives in STEM and hinders the full realization of talent and potential nationwide. The National Center for Education Statistics estimates that student parents, who account for more than one-fifth of all college students, number nearly 4 million [3]. Balancing the demands of rigorous STEM coursework with parental responsibilities can be particularly daunting, as these students often have limited access to affordable childcare and support services [4]. Additionally, parenting students face challenges accessing free or low-cost high-quality STEM education during the summer months, particularly options that work with their summer college course schedules.

The Holistic Oasis for Parents' Education (HOPE) Program at Hostos Community College is designed as a groundbreaking two-generation (2Gen) initiative to address the unique challenges faced by underrepresented college student parents who are pursuing STEM degrees or taking STEM courses for professional degrees and certifications (i.e. nursing, dental hygiene, radiologic technology) while simultaneously providing enriching STEM experiences for their children. Hostos Community College, located in the South Bronx, epitomizes educational accessibility and community involvement. Since its founding in 1968, Hostos has defended diversity and academic excellence, offering various programs and support services, including on-campus childcare since the 1980s. The HOPE Program, rooted in the college's resilience and community engagement history, is building a framework to serve our parenting students and caregivers, who comprise nearly one-third of our student population. From its origins in community activism to its present-day commitment to empowerment, Hostos and the HOPE Project embody the spirit of progress and strength in this urban landscape.

Figure 1: *The HOPE 3D Model*



[1] Racial disparities persist in STEM degree completion, with white and Asian students having higher completion rates than Black and Hispanic students; the literature review in this article points out a number of factors including racialized course-taking patterns, particularly in mathematics, teacher quality leader to weaker pre-college preparation, and a college STEM culture in which instructors are distant and unapproachable with colleges lacking supplementary support. [1].

[2] Racially minoritized students face barriers in accessing high-quality STEM education and opportunities due to factors such as lower academic preparation before secondary school, racialized lower quality educational contexts, inadequate psychosocial characteristics for STEM success, exposure to non-inclusive curricula and pedagogical practices, limited family social/cultural and financial capital, and fewer informal STEM opportunities [2].

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The HOPE Program's Three-Dimensional Model addresses a variety of barriers by providing support in three crucial areas: academic (tuition gap assistance, Experiential Learning Opportunity (ELO) summer STEM courses, and a dedicated learning community of student parents), family (free summer childcare (ages 0-11), breakfast and lunch, and ELOs for the parent and child), and professional (daily lunch-and-learns) (Fig. 1). HOPE Scholars can fully engage in their summer STEM coursework without compromising their parental duties, thus creating a more conducive environment for academic success. Moreover, recognizing the importance of early exposure to STEM education, especially for children from underrepresented backgrounds [5], the HOPE STEM Academy offers engaging and enriching STEM education. By integrating the STEM education of parents and children, HOPE adopts a Two-Generation Model, which benefits parenting students and their children and fosters a supportive and inclusive community environment where STEM education is valued and accessible to all.

In [6], the author conducted a single case study examining the impact of collaborative inquiry- and design-based learning on elementary students in a STEM summer camp. They found that students enjoyed collaborative, hands-on activities, and parents sought sustained exposure to STEM and real-world applications for their children. According to [7], informal outreach programs offer valuable science experiences for elementary students, addressing the potential loss of interest in science observed in middle school and emphasizing the importance of early engagement. Lauren von Klinggraeff et al. conducted a pilot study comparing the Healthy Summer Learners (HSL) program [8] to an active comparator (21st Century Summer Learning Program) and no-treatment control, aiming to prevent accelerated summer BMI gain and academic learning loss among low-income 2nd to 4th-grade children.

Part of our model is to improve the undergraduate STEM experience by incorporating an ELO component into summer STEM courses, which offers HOPE Scholars an opportunity to apply their theoretical knowledge in real-world settings, enhancing their understanding and mastery of STEM concepts [9]. By engaging in ELOs such as service-learning, students gain practical experience and develop critical thinking, problem-solving, and communication skills essential for success in STEM careers [10]. Additionally, the collaborative nature of service-learning projects [11] fosters teamwork and leadership skills, preparing students for the collaborative environments commonly found in STEM industries. Moreover, the direct impact of their work on the community provides students with a sense of purpose and motivation [12], reinforcing their commitment to STEM disciplines while promoting a broader understanding of the societal relevance of their academic pursuits.

II. Program Design

A. Program Participants

Enrollment in the HOPE Program has increased during its first two years from 13 in 2022 to 21 in 2023; all have identified as female/ mother except one male/father. Compared to our college demographics, HOPE Scholars are more likely to be older than the average student and a larger percentage of Black/African Americans [3] [13]. Our participant survey reveals that a significant number of these mothers are single and below the federal poverty level for a single person[4] living in a household size of 3 to 4 people and responsible for at least one child (Table 1).

Table 1: *Demographics of HOPE Scholars.*

	Year 1	Year 2
	HOPE (n = 9)	HOPE (n = 21)
	%	%
Female	88.9	100.0
Hispanic/ Latinx	33.3	33.0
Black/ African American	66.7	57.0
Age (35-45)	44.4	48.0
Household Size (3-4)	66.0	62.0
Children (below 18 years old) (1 child)	44.0	52.0
Children (below 18 years old) (3 or more)	44.0	24.0
Marital Status (Married)	44.9	43.0
Martial Status (Never Married)	56.0	43.0
Total Annual Income (less than $12,880)	55.6	67.0

B. STEM Academy Toolkit for Children (Ages 5-11)

The HOPE STEM Academy is designed to provide enriching ELOs that foster a passion for STEM subjects. In 2022 and 2023, the STEM Toolkit included bridge-building and Raspberry Pi modules. The **Bridge-Building Module** introduces students to engineering, construction, and structural design principles through hands-on activities [16]. Students learn about the forces acting on structures and how different materials and designs can affect the strength and stability of bridges. Students gain insight into the engineering design process and the importance of structural integrity through practical exercises, such as building model bridges using materials like popsicle sticks or straws. This module enhances students' understanding of physics and engineering concepts. It develops their critical thinking, problem-solving, and teamwork skills as they collaborate to design and construct bridges capable of withstanding specified loads. The **Raspberry Pi Module** introduces students to computer science, programming, and electronics using Raspberry Pi, a small and affordable computer. Students learn to set up and program Raspberry Pi devices, gaining hands-on experience with coding languages like Python and utilizing sensors and peripherals to create interactive projects. The module covers

[3] According to the last year of available enrollment data, 70% of students enrolled at Hostos Community College in the Fall 2020 semester were female, 59% were Hispanic, and 25% were Black. Only 8% of the total were between 35 and 45 years of age [13].

[4] The federal poverty level for 2021 and 2022 was $12,880 and $13,590, respectively [14], [15].

basic programming concepts, sensor integration, algorithm design, and the Internet of Things (IoT), providing students with a foundation in digital technology and computational thinking.

C. STEM Experiential Learning Opportunity (ELO) Fellows

Implementing a high-impact practice like ELOs into summer STEM courses requires professional development and mentoring. Our STEM ELO Fellows initiative provides faculty with the necessary support and guidance. For various reasons, this component of the HOPE Program was stalled in 2022 and 2023 (see "Challenges"); however, we recruited two STEM faculty for Summer 2024. . We invited them to a professional development workshop that will take place before the summer session starts. The focus of the workshop will be to introduce ELOs and their benefits, demonstrate how to design and implement an ELO module within their courses with a template on air pollution designed by co-PI Jiang, and encourage faculty to begin to connect this template with their course learning objectives (i.e. biology, chemistry, and mathematics) and create a module for their summer class. This adaptable module enables faculty members to seamlessly integrate it into their courses while maintaining relevance to their specific course objectives. Co-PI Jiang will mentor the STEM ELO Fellows, visit their classrooms, and provide ongoing feedback. Our mentor model will ensure faculty have the necessary support to create clear learning objectives, project guidelines, and assessment criteria. HOPE STEM ELO Fellows will implement the newly developed module during the summer session and receive ongoing mentorship and guidance. Mentor feedback and student assessment data will inform a module revision at the end of the summer session. Survey data from HOPE ELO STEM Fellows will guide and inform the professional development design. Faculty will be encouraged to implement the revised module throughout the academic year and share assessment data, fostering a culture of continuous improvement and innovation.

III. Preliminary Findings, Challenges, Future Plans

A. Preliminary Findings

Through a series of focus groups with HOPE Scholars, we asked questions about the impact of the HOPE STEM Academy. Qualitative data from three separate focus groups provide valuable insights from the parents on their children's experiences. The feedback from parents underscores a notable rise in academic involvement among children enrolled in the program, with instances of improved reading skills and growing interest in STEM subjects. Additionally, parents highlighted their children's enthusiasm for learning, reflecting positive cognitive development. Many parents expressed satisfaction with the program, noting their children's desire to continue participating and emphasizing its positive impact on their academic interests and personal growth. Parents said that their children demonstrated enhanced academic performance and readiness for the school year and observed smoother transitions for their children upon returning to school, attributing increased independence and academic confidence to their participation in the program.

Furthermore, positive behavioral changes, such as improved social skills and emotional awareness, were noted, indicating enhanced emotional resilience among participants. Children's active engagement with the Hostos community further highlights the program's success in fostering a supportive learning environment and promoting aspirations toward higher education in STEM fields. The results of the HOPE Program reflect its positive impact on promoting STEM education and facilitating holistic academic and personal development among participating children.

Many HOPE Scholars contrasted their children's school experiences with the HOPE STEM Academy during these focus groups. One father said they experienced racism in his kids' school from their teachers, while another mom said the school's solution to everything was to send her 7-year-old son to the principal's office. According to his mom, that same 7-year-old "flowered" in the HOPE STEM Academy, "Here I guess he feels a sense of respect...that his voice matters." Most parents expressed their children's desire to continue participating in the program, indicating high satisfaction with the educational experience provided. Many children expressed a keen interest in returning to the program, emphasizing the positive impact on their interests in STEM subjects and personal development.

In 2023, all HOPE STEM Academy students took mathematics and reading placement tests. Using these results, we created academic summer goals for each child, shared them with their parents, and reported progress at the end of the summer. Children's engagement with the Hostos community was evident, with some expressing a desire to explore campus facilities and interact with college staff. One participant's child expressed enthusiasm for attending cultural events at Hostos, indicating a sense of belonging and aspiration toward higher education. Overall, the results of the HOPE Program suggest positive outcomes in promoting STEM education, fostering a supportive learning environment, and enhancing academic and personal development among participating children.

B. Challenges

The development of the STEM Toolkit took place during the Spring of 2022 and was implemented for the first time in the Summer of 2022, leaving little time to pilot it before full implementation. The Bridge Building modules had been implemented in a summer program and were adapted by their creator, Joseph Gullo, for the HOPE STEM Academy. A doctoral student, supervised by co-PI Jiang, designed the Raspberry Pi curriculum in the Spring of 2022, and its pilot

was the 2022 HOPE Academy. The latter required supplies and space that were costly and difficult to obtain, and the technical language and complex concepts needed to be more suitable for elementary-aged kids. The Raspberry Pi modules will be adapted for a future middle school HOPE STEM Academy and shared with other middle school programs.

Another challenge we faced in both 2022 and 2023 was the need for a STEM teacher; in both summers, a STEM teacher was hired and quit before the end of the first week, leaving the lead teacher, PI, and co-PIs scrambling. While the Bridge Building Modules were easy to implement, we realized that we needed to brand and package the materials so that they are more readily accessible for instructors and can be shared with other STEM instructors on our website.

Despite heavy recruitment efforts in 2022 and 2023, we could not launch our HOPE ELO STEM Fellows initiative. One of the primary challenges we have faced is the prevalence of online courses across STEM courses and the time constraints of full-time faculty during the summer months. Our workshop is in-person, and the courses we want to target must have in-person components, which leaves us few faculty to recruit. Furthermore, the way HOPE Scholars are admitted to the HOPE Program often occurs at the end of the semester, leaving little time for us to identify which instructors they will have in their summer STEM courses. Changes within our university system precluded us from offering stipend payments; instead, any compensation is processed as summer salary, which is much more costly. Finally, there is also a perception that ELOs, particularly service-learning, are very labor intensive, which might have deterred interested faculty from pursuing the initiative in 2022 and 2023. Our campus all-calls to summer STEM faculty yielded very few responses and almost no eligible faculty participants.

C. Future Plans

We have recruited a STEM instructor, finalized the engineering and circuits modules in our newly packaged STEM Toolkit, and are working on preparing pre/post-testing and increasing our baseline assessments of students as they enter the HOPE STEM Academy. During the 2023-2024 academic year, our STEM Toolkit team, comprised of consultant Joseph Gullo and our lead teacher from the 2023 HOPE STEM Academy, Carolina Laguna (who became a consultant), worked with a designer, Professor Joshua Muntain, to 1) create a new technology module ("Circuits"), 2) review all STEM Toolkit materials for readability, scaffolding, and ease of use for instructors, and 3) brand and package the STEM Toolkit instructional materials. During the 2024-2025 academic year, Mr. Gullo will lead the STEM Toolkit team to develop our final three modules—science, mathematics, and art. Our final STEAM Toolkit will be ready for the Summer of 2025. We are adding a few items to our Internal Review Board (IRB) application, including dyad interviews with parents and kids to better ascertain the kids' perception of the HOPE STEM Academy and interviews with HOPE STEM Academy teachers. In 2025-2026, we will refine the STEAM Toolkit, using assessment and evaluation data from previous years, and publish the STEAM Toolkit with a Creative Commons license and share it with summer programs and New York State elementary schools.

Our 2024 STEM ELO recruitment has been extremely targeted, small, and personal, with the added incentive of summer salary. We also increased support, including one-on-one mentoring with an experienced STEM ELO practitioner, classroom visits, and support while revising the newly created STEM air pollution modules. We also plan to engage these faculty in our HOPE Program Celebration, recognizing them for their contributions to improving STEM education.

IV. Conclusion

The article emphasizes the importance of 2Gen STEM education and the Holistic Oasis for Parents' Education (HOPE) Program's interventions. The program's Three-Dimensional Model incorporates an ELO component into summer STEM courses, providing students with practical experience and essential skills for STEM careers. The HOPE STEM Academy offers early exposure to hands-on STEM education and 2Gen ELOs for HOPE Scholars and their children. It supports parenting students pursuing STEM education by removing barriers like childcare and fostering a supportive community environment for academic success. The preliminary findings of the HOPE Program indicate positive outcomes in promoting STEM education and fostering a supportive learning environment for participating children.

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AUTHOR INFORMATION

Biao Jiang, Associate Professor, Department of Natural Sciences, Hostos Community College.

Norberto Michel Hernandez Valdes-Portela, Instructor, Department of Behavioral and Social Sciences, Hostos Community College.

JungHang Lee, Assistant Professor, Department of Mathematics, Hostos Community College.

Sarah L. Hoiland, Associate Professor, Department of Behavioral and Social Sciences, Hostos Community College.