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R D. Davis
zwilson@lsu.edu

L Winfield

D Spivak

Z S. Wilson-Kennedy

R D. Davis

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Role of International Research Experiences in the Development of Women of Color in Chemistry

Raeshan D. Davis, Leyte Winfield, David Spivak, and Zakiya S. Wilson-Kennedy*

ABSTRACT: As undergraduate students cultivate their scientific knowledge and abilities, several high-impact educational practices such as undergraduate research and global experiences have proven exponentially beneficial for their development and success. Current literature on underrepresented racial and ethnic minorities has focused primarily on the impact of undergraduate research on this subpopulation. However, fewer studies have explored the impact of global research experiences and women of color in international research experiences. Grounded in the theoretical frameworks of Social Cognitive Career Theory, Intersectionality, and Community Cultural Wealth, this present study explored the impact of international undergraduate research experiences on women of color from groups underrepresented in chemistry. We found that, after participating in international research, women of color from historically underrepresented groups (1) were aware of the realities of being a woman and a minority in STEM, (2) had utilized a wealth of cultural capital to navigate the international research experience, (3) had recognized the value of the international research experience on their personal growth, and (4) had recognized the benefits of their international research experience on postundergraduate pursuits. The findings suggest that international research experiences contribute substantially to the holistic development of women of color in scientific disciplines such as chemistry.

KEYWORDS: Chemical Education Research, Upper-Division Undergraduate, Interdisciplinary/Multidisciplinary, Collaborative/Cooperative Learning, Undergraduate Research, Women in Chemistry

FOCUS: Chemical Education Research

Scholars, academic leaders, and policy makers have grappled with strategies to address the attrition of students from scientific disciplines. High-impact practices such as undergraduate research, global and capstone experiences, common intellectual experiences, learning communities, and communication-intensive courses (written and oral), among others, have been explored for their efficacy in supporting students’ identity development and acclimation to the disciplines and culture of the scientific community.1–3 As these experiences have been explored, several leaders have postulated that combining or layering these practices could have positive and potentially additive effects on student outcomes. Studies testing this hypothesis have found that layering high-impact practices can yield positive student outcomes.4

Within this context, the current project explores the impact of global undergraduate research experiences on students’ development as scientists and their ideations of a scientific career. Global educational experiences have the potential to be transformative for students with access to such opportunities.5–7 While it is common for senior professionals in academia, industry, and other fields to actively engage in international research for collaboration and the advancement of innovation with respect to their disciplines, it is less common for students at the undergraduate level to have these global experiences. The significant financial commitment of such experiences and flexibility in the academic major are limiting factors to access. Of the students that engage in these types of experiences, few United States (U.S.) students from underrepresented racial and ethnic minority (UREM) groups participate in study abroad or study travel,8 and fewer still conduct research abroad during this very formative period of their development as scientists.

To catalyze STEM student access and training in global research, the U.S. National Science Foundation (NSF) has taken a targeted approach by dedicating substantial funding to supporting international undergraduate research experiences (iREUs). With this expansion of research offerings, under-
graduate students are afforded a unique opportunity to engage in scholarly research pursuits and collaborations worldwide and broaden their perspectives of other countries and cultures.

While extensive studies have investigated the impact of undergraduate research on student development and retention, fewer studies have explored how these experiences in international research settings impact student learning and development.\textsuperscript{9–11} Noting the limited exposure of STEM undergraduates to international experiences, URM in these disciplines are even more underrepresented than their peers in having global experiences. As we seek to understand how international research experiences impact those with access to these, it is imperative to include the impact of international undergraduate research on students from minoritized groups.

The seminal works, the Double Bind and Revisiting the Double Bind, highlight the intersectional context in which women of color from underrepresented groups navigate complex socioprofessional dynamics as students and as professionals in the workplace.\textsuperscript{12–14} With this understanding, the purpose of this present study is to explore the development of science self-efficacy and confidence in women of color after participating in an international research experience. As we seek to broaden the participation of groups underrepresented in the scientific workforce, it is important to also attend to the complexities of intersectional identities.

\section*{LITERATURE BACKGROUND}

Fundamentally, this empirical study considers how two intersecting high-impact practices, i.e., undergraduate research and global experiences, influence the development of women of color from groups underrepresented in STEM and their actualization of becoming STEM professionals. Noting that academic and professional training are critical components of a student’s intent to pursue a career in a STEM field, this research study is grounded in Social Cognitive Career Theory.\textsuperscript{15} Additionally, noting the intersecting identities of being a woman and a member of a minoritized racial and/or ethnic group, this research study also considers Community Cultural Wealth Model\textsuperscript{16} and Intersectionality\textsuperscript{17} theoretical frameworks in the research design. As such, the study presents a conceptual model integrating these frameworks to promote the development of undergraduates as scientists (Figure 1). This model will investigate minority students’ perceptions of the impact of international research experiences on the ideation of becoming a scientist, research confidence, and intercultural awareness. We hypothesize that these factors are essential to women of color actualizing goals of a STEM career.

Social Cognitive Career Theory (SCCT) is the foundation of the conceptual framework for the study reported here. Developed by Lent and colleagues, SCCT posits that individuals approach career development in three interrelated aspects: (1) self-efficacy, (2) outcomes, and (3) personal goals.\textsuperscript{15} Thus, individuals who believe or have confidence in their abilities to reach a favorable outcome are likely to pursue opportunities to achieve their goals. Consequently, SCCT illustrates the impact of affirmative growth opportunities. As students meet and achieve their goals, they develop confidence (self-efficacy) in their ability to do well (via outcomes) on future challenges (goals). Even if each outcome is not ideal, if the students are learning, rewarded and adapting through the process, they can develop confidence in their abilities to achieve their goals. Notably, the model considers the impact of one’s identity on their educational and career development process.

Central to the conceptual framework is the Community Cultural Wealth model (CCW). Grounded in a critical race theory as a retort to traditional assumptions of cultural capital,\textsuperscript{20} Community Cultural Wealth models present the forms of capital possessed by students of color that often go unnoticed but are vital to their success.\textsuperscript{16} Yosso offers six forms of capital: Aspirational (goals and dreams), Linguistic (communication skills), Familial (social and personal resources from one’s family), Social (support from peers and community), Navigational (ability to navigate social institutions), and Resistance (ability to advocate for needs). As women of color in STEM progress through their academic journey, it is essential to factor in the strengths, talents, and experiences of cultural capital that support their success, even and despite the complex socioprofessional environments that they are navigating. In this way, CCW is a source of self-efficacy and outcome expectation that these individuals bring to each learning and professional experience in which they engage.

Intersectionality suggests that those with multiple identities are often subject to exclusion, isolation, inequitable treatment, and other forms of oppression.\textsuperscript{17,18,23} Crenshaw offers Intersectionality as not just limited to race and gender,\textsuperscript{18} but also should be extended toward class, sexuality, and other forms of oppression.\textsuperscript{19} Scholars have suggested that the field of STEM is based on traditional white, majority values, which may explain the low representation of women of color.\textsuperscript{22} As such, STEM educators and researchers realize the potential of this framework...
Intersectionality can be used to challenge the intersecting identities are impacted by their experiences in understanding how students become aware of how their and career decision-making. This framework can also be used to and other -isms, these experiences can impact their academic and professional spaces, and experience systemic racism, sexism, individuals with diverse intersecting identities navigate academic and psychological and academically (i.e., outcomes). As individuals with diverse intersecting identities navigate academic and professional spaces, and experience systemic racism, sexism, and other -isms, these experiences can impact their academic and career decision-making. This framework can also be used to understand how students become aware of how their intersecting identities are impacted by their experiences in STEM. Lastly, Intersectionality can be used to challenge the policies and practices that are oppressive and do not advance women of color in STEM.

The theoretical framework that guides this research design (1) adapts the SCCT Model from Lent’s work, (2) integrates Community Cultural Wealth and Capital as a source of self-efficacy and outcome expectations, and (3) utilizes Intersectionality as a lens through which these expectations influence career decision-making. The cultural wealth that individuals with diverse and intersecting identities bring to the table is an asset. How their talents and other attributes are cultivated must be examined through Intersectionality, thereby accounting for the environmental factors that impact self-efficacy and outcome expectations and leading to career decision-making and outcomes.

RESEARCH QUESTIONS

Severely underrepresented throughout higher education and the scientific workforce, women of color navigate complex socio-professional environments due to the nature of systemic racism and sexism in the United States. Within minority populations in the U.S., the focus on racial and ethnic equality has historically limited the focus on gender equity, the intersection of race/ethnicity and gender, and the needs of these women with diverse racial and ethnic identities. Moreover, while literature highlights the significant barriers that (white) women experience as they navigate academic training at the undergraduate and graduate levels and when they enter into the scientific workforce, fewer studies have focused on women of color. The silencing and invisibility of women with diverse intersectional identities in academic and professional spaces within the scientific community dramatically impacts the understanding of how to support these individuals. This paper focuses on women of color from groups underrepresented in STEM and investigates how international undergraduate research experiences, a combination of two high-impact practices in higher education, contribute to their development as a scientist and their intercultural competence and awareness of global research and collaboration. To this end, the work reported here explored the impact of international undergraduate research experiences on women of color from groups underrepresented in chemistry majors. This study has three guiding research questions:

1. How are international research experiences contributing to the educational experience of WoC chemistry undergraduates?
2. How do participants describe their growth in intercultural competence after living and working at an international research site?
3. How does WoC participation in undergraduate international research programs support their actualization of being a chemist?

We note that women of color bring the wealth of assets to the academic and professional workplaces and postulate that this wealth should also be considered. We note that many scientific workplace environments in the U.S. and abroad privilege men and maleness. We also note that being a U.S. trained scientist also carries privileges in many research environments abroad. Consequently, the lived experiences of women of color from groups underrepresented in STEM, navigating research environments abroad, provide a rich context for exploring the research questions that have been posed.

RESEARCH METHODS

A qualitative research design was employed to allow for an in-depth, rich exploration of the unique experiences of the participants in this study. The work was part of a larger study exploring the role of international research experiences on the development of minority undergraduate scientists. Noting the small numbers of minority students engaging in international research experiences, a qualitative study can deepen the understanding of this critical population and their lived experiences within and beyond their engagement in international research as an undergraduate. To generate such empirical findings, therefore, this study focuses on the
experiences of women of color engaging in international research experiences.

A single case study approach was employed to gain a comprehensive understanding of complex issues, topics, or problems within their real-world context. As prescribed by Yin,39,40 case study research explores a real-life, bounded system (case) through multiple forms of data. For this study, the bounded case explored the experiences of underrepresented minority women of color who participated in international research experiences as undergraduates. A single case study approach was utilized to gain an in-depth understanding of international research and cultural awareness within a real-world context for these women of color.37−40 The Louisiana State University IRB office approved of his study (IRBAM-20-058801). The study also underwent review by the Spelman College IRB committee, who deferred to the LSU IRB approval.

Participants

The population of interest for this study was selected using convenience sampling based on the following criteria: (1) being at least 18 years old, (2) identifying as a woman, (3) self-identifying in one or more of the specified race/ethnicity groups (Black/African American, Latina, Native American/Alaska Native or Native Hawaiian/Pacific Islander), (4) being enrolled in or graduated from a STEM undergraduate program, and (5) having participated in at least one international research experience during their undergraduate academic career. All participants of this study completed at least one summer in the international research program before Summer 2020. The interviews were conducted between November 2020 and March 2021. The participants included nine women of color: five identifying as Black/African American, two identifying as Latina, one identifying as Mexican/Indigenous Ancestry, and one identifying as Native American. All participants engaged in at least one undergraduate research program prior to their immersive international research experience. Participants created their pseudonyms to ensure their identity remained confidential and referenced in the findings and discussion portion (Table 1).

Data Collection and Analysis

Aligned with the case study design, researchers in this investigation collected multiple forms of data, including documents and interviews.36,41 The primary mode of data collection was one-on-one semistructured interviews that lasted approximately 60 minutes. Interviews were conducted and recorded on the Zoom platform. The interview protocol explored their undergraduate degree path, current career and education path, international research program logistics, experience as a woman of color in STEM and research, and a reflection of their growth in research abilities and intercultural competence. The study’s conceptual framework was utilized to develop the interview protocol and research questions guiding data collection. Also, the NSF-REU program grant reports, international research program websites, and promotional material were reviewed to gain a better understanding and context.

For the data analysis, each participant’s interview audio was transcribed verbatim using a transcription service to ensure accuracy. Next, transcripts were uploaded in Dedoose qualitative coding software and read thoroughly to understand each participant’s narrative and experience.42 Initially, each transcript was open-coded to identify preliminary subcategories from each participant. The focus of the open-coding phase was to understand the participants’ experiences as presented from their interviews. This approach allows the researchers to be objective to the data presented. After open coding the nine transcripts, several rounds of axial coding were conducted to determine the relationships between the subcategories to group subcategories into major categories.43 The final codebook consisted of 10 major categories. Next, the final codes were categorized by the research questions. The purpose of this categorization was to begin the thematic analysis process and answer the research questions. The next step in the thematic analysis is utilizing the codes and excerpts to illuminate the emerging ideas aligning with the research questions. The thematic phase utilized the study’s conceptual framework as the lens to interpret and understand the data and illuminate the emerging ideas and themes. The emerging ideas were then categorized by concept relationships to determine the themes. The final step consisted of organizing these emerging themes into overarching concepts to illuminate the final themes of the research study. Throughout the data analysis process, the research team employed several trustworthiness strategies,34 with the primary method being peer-debriefing with the researcher throughout the coding process.35 Another significant trustworthiness measure used during the data analysis process was the individual documentation of each analysis step performed.

Positionality Statement

Collectively, the research team has various experiences working with the undergraduate science students and science opportunities. The first author (R.D.D.) is a Black woman doctoral candidate at a PWI (predominantly white institution). Her research agenda focuses on designing and implementing academic opportunities for the retention and success of historically underrepresented student populations in STEM fields.

The corresponding author (Z.S.W.-K.) is a research faculty member in chemical education and an administrator within the College of Science at a PWI. As a leader on almost $30 million in extramural support from NSF, NIH, USDoEd, and philanthropic agencies, she has designed and implemented over 20 education projects, which have employed mentoring models to create and test development structures that cultivate self-efficacy and agency, particularly for groups historically underrepresented in STEM.

The second author (L.W.) leads NSF-funded research to increase the participation and success of underrepresented groups in STEM and chairs the internal steering committee for the newly established Center of Excellence for Women of Color in STEM at Spelman College. Her research focuses on creating culturally relevant learning environments and characterizing the impact of such environments on student agency.

The third author (D.S.) is a professor in the Department of Chemistry at a PWI and the Principal Investigator for an NSF-funded International Research Experiences for Undergraduates in France and Belgium in collaboration with the LSAMP program.

FINDINGS

After analyzing the interview data and documents, four salient themes emerged across the nine participants.
Theme 1: Realities of Being a Woman and a Minority in STEM

Participants discussed their heightened awareness of being a woman and a minority in the sciences in an international setting. Most participants shared that their first encounter with the challenges of being a woman of color in STEM occurred during their international research experience. Mary shared the following sentiments:

“For me personally, with my experience here at my PWI, I haven’t had any issues being a woman, but it was very interesting; in fact, some of the first issues I found experienced were when I went to study in France. It was just a very different culture.”

Similar to Mary, several participants recounted offensive personal and professional encounters provoked by their race or gender or a combination of both. For some participants, their mentors proactively prepared them for potential instances of sexism and racism they could encounter. Specifically, Kay explained:

“We talked about how in other countries, being a woman of color isn’t necessarily something that’s praised. You may get certain looks from people and to expect those things. I felt like going into those experiences, I wasn’t blind at all to what I might experience.”

On the other hand, several participants shared their negative encounters, which caught them off guard and opened their eyes to the real-world challenges for women of color in STEM. Natasha recounted an experience of being stereotyped as a “hood Black girl” by a fellow researcher. She shared the following:

“It was just like at that moment, it hit me that it doesn’t matter that I’m getting a whole undergrad degree in engineering from one of the top universities in the U.S. All they saw was this black girl... that was a very eye-opening experience.”

Similar to Natasha, Mary shared in her interview the instances when she felt targeted as a woman. Specifically, she disclosed the following:

“In regards to being a woman, I experienced things there that I had never experienced anywhere else... In France, I had three or four instances where I was like, ‘What is this?’... One of the male professors, he was in my field of chemistry but he was not my advisor. He came in and he was like, ‘She probably doesn’t understand anything you’re saying.’ I was like, ‘It’s a French accent. I’m not stupid.’”

Despite their undesirable encounters, several participants recognized the importance of their presence as women in STEM. Kay shared these sentiments:

“I always noticed how people were so shocked to see Black women... I was able to really be maybe the first black woman that someone in South Africa saw doing work to help them and improve their livelihood... This experience really led me to want to be a change agent. I decided to get my PhD... I felt that, by having my PhD, I could really do powerful, impactful research... being able to impact people so directly.”

Theme 2: Utilization of a Wealth of Cultural Capital to Navigate the International Research Experience

Each of the participants described the relationships, assets, and resources they utilized to access their international research opportunity. Most notably, participants attributed their awareness and motivation to apply international experiences to their mentors. Specifically, Emily shared:

“I didn’t really understand what it meant to go into higher education and what were my career possibilities until my research professor... He opened a lot of doors for me and I met a lot of different people... Actually that’s how I learned about this program, and he pushed me to apply.”

Amber, Mary, Rihanna, and Taylor recounted similar experiences of their mentors being the driving force behind them applying to international research programs. Rihanna shared:

“Having my mentor, she made it known, you’re going to be one of the few Black people in your field, wherever you go, so just make sure that you brought the best foot forward at all steps and make sure that no one can question your ability or why you got here’... To me, it meant making sure that I apply for anything and everything I could apply for to make sure that no one could question my qualifications.”

For most of the participants, mentors affirmed the possibility and feasibility of participating in an international research program as finances were a significant factor to their participation. Tiffany explained:

“It was my advisor actually telling me about the opportunity. I had no idea that program existed. I had always wanted to do study abroad, but I learned about the programs, and oftentimes you have to pay for them. I was already struggling to get through college, there’s no way that my family really can afford for me to do a study abroad... This was my opportunity, and it was something that I could work and still get the experience internationally.”

Another significant resource noted by participants was their educational communities. The participants who attended Historically Black Colleges and Universities (HBCUs) and Hispanic-Serving Institutions (HSIs) discussed how their academic environments rooted in serving historically underrepresented students cultivated a support system for their academic pursuits. Kay recalled her HBCU’s intentional push for students to gain international exposure in their fields. Specifically, she explained:

“The Quality Enhancement Program at my HBCU pushed students to get global experiences. At the time, everybody at my HBCU was doing something global... I think having that culture at my HBCU really pushed me to pursue international opportunities.”

Similarly, Emily shared how her HSI gave her “a sense of belonging and a very nurturing environment before going to France”.

Parallel to this, several students who attended predominantly white institutions (PWIs) discussed how the use of their familial and social capital affirmed their identities and supported their educational pursuits. Natasha shared how the influence of growing up around Black doctors and teachers affirmed her confidence to pursue her dreams as a Black woman in STEM. Similarly, Taylor discussed not only how the people of color community broadly at her PWI give her a community that “knew what I was going through not just as a woman but also a woman of color”, but also how her STEM organizations provided a network of peers to share potential academic opportunities such as international research.

Theme 3: Recognized the Value of the International Research Experience on Their Personal Growth

Each participant recognized their personal growth as a benefit of participating in research in an international setting. Several of
the participants discussed how living in another country developed their independence and ability to navigate new places. For most of them, this experience was their first time traveling outside of the United States. Taylor, Tiffany, and Natasha shared that growth in their independence was the most rewarding part of their international experience. Specifically, Tiffany explained:

“I felt independent because I had to navigate and figure out things on my own... it was really the first time being on my own in an environment where I just didn’t know anyone, and I also didn’t know the language very well. It really showed me that I can survive in that type of situation as well.”

The independence cultivated through navigating a new environment also affirmed their sense of belonging in their career pursuits. Taylor eloquently explained:

“Being in a different continent pushed me outside of my comfort zone. I was extremely independent now... and that carried on into the lab also... They had so much confidence in me that I had confidence in myself to be independent because they clearly wanted me... I deserved to be here... It gave me the confidence in myself to be independent in the lab and everything as well.”

Although the international research locations and duration periods varied across participants, they all expressed an immense appreciation for this unique, immersive experience to meet individuals from diverse backgrounds. Mary explained how her engagement with lab peers from other countries expanded her awareness of inequities in race and ethnicity. Specifically, she explained:

“For me personally, the best part was just the culturally enriching experience of seeing things from other people’s perspective. Ironically enough, it was not even from the French perspective; it was from two Ph.D. students from Mexico and South America. I am white-passing, and so there is a privilege that comes with that. It was just interesting to see, and not things that I did not know, but it was things that I had never heard from a person in real life before versus reading it online, reading studies, and things like that.”

Similarly, Tiffany shared how her perspective to other ways of life expanded. She explained:

“I was in my little bubble when I went over there... but when you are immersed like we were... it taught me to respect the way people live and the way they move about the world and being open-minded to other ways of living.”

For two of the participants identifying as Black, they had the unique opportunity to explore historical contexts of their Black identity. Amber passionately shared the following:

“It’s a wonderful experience to be able to go to the motherland in which we were taken and stolen from. I visited Cape Castle, Elmina Castle and see how sad it was for us to be in the dungeon before we went over the middle passage... this was very moving.”

Theme 4: Recognized the Benefits of their International Research Experience on Postundergraduate Pursuits

Participants described how their engagement in international research confirmed their career paths and graduate school pursuits. As Rosa reflected on her IRE experience, she shared:

““The international research experience helped me to reinforce the idea that I wanted to get a Ph.D. and that I wanted to get into academia, regardless of the obstacles and all the things that we know are ahead of us.”

Similarly, Natasha shared how her experience affirmed her career path and her desire to support other women of color in STEM. Specifically, she explained:

“From that experience, it makes me keep debating becoming a professor... my advisor in France was a woman, which was great. I think the only woman in that whole department... I get to see this, and I’m like, ‘I could be that for somebody.’”

All participants shared how their participation in international research developed their research self-efficacy and abilities in a lab setting. When asked to describe their skills development, participants recounted various techniques and skills acquired during their international research experience. Specifically, Tiffany discussed how she was exposed to developing research projects from start to finish. She explained:

“I worked with a graduate student that was in the research advisor’s lab and supported him in synthesizing some new compounds... what I learned from that experience was really how to be a graduate student and what was required of him... he shared that with me that you’re going to be responsible for your own research project and that was really eye-opening.”

Several participants discussed how this international research experience opened their minds to the possibility of global collaboration and adaption of existing research to their areas of interest. As Amber reflected on her exposure to research conducted internationally, she shared these sentiments:

“There’s so much that you can learn from other well-renowned scientists and researchers abroad... In collaboration, based on your research, you may say, this worked in this population in Asian patients or African patients. I wonder how this context would work in Black patients in a rural community. I wonder how this may work here in America because we all are using papers to help develop our idea.”

Not only did the international research experience promote an exchange of scholarly ideas, but also participants shared the growth of their professional network with peers from their programs. Amber, Taylor, Natasha, and Mary expressed similar sentiments about their connections from their international experience. Taylor’s sentiments summed it up perfectly:

“The other students that I established a network with eventually will become my colleagues in the future. As we move through our programs, it is important because they can point out different opportunities that maybe I do not know about or other people might know about because it is in their immediate sphere, and we share them with each other.”

For participants further removed from their international experience, they still acknowledge how monumental this opportunity has been to their career pursuits. Amber, Tiffany, Kay, and Rihanna expressed similar sentiments of standing out in their career pursuits because they participated in international research. Specifically, Tiffany shared:
“In my career right now, I still tell people that I went to France, and they are impressed... there is so much that you learn by being in that type of experience, doing research, working on a project, but then also learning the culture. Also, it has helped me progress in my career because people realize you are different when having that on your resume. You have a completely different experience from someone that may have done research in the U.S.”

**DISCUSSION**

As a part of a larger study on the role of international research on the development of minority undergraduate scientists, the nine participants illuminated significant observations directly related to their identity as women of color in STEM. Social Cognitive Career Theory (SCCT), Community Cultural Wealth Model (CCW), and Intersectionality theoretical frameworks were utilized to answer the three research questions.

The participants’ reflections and observations of their international research experiences answered the first research question by illuminating the numerous benefits which enhance the value of the training of women of color in STEM undergraduate programs. Aligned with the self-efficacy and outcome expectations of the SCCT model, most of the participants shared specific examples of how their participation in international research supported their career paths and graduate school pursuits. Through the lens of the Intersectionality of being a woman and minority in science, the participants further described how international experiences not only raised their awareness of the inequities of women of color in STEM fields but fortified the need for their persistence and representation.

In exploring the first research question, a prominent theme of cultural wealth and capital was apparent across the collective experiences of the participants. Aligned with the Community Cultural Wealth model, we observed that women of color in the research study actively utilized their strengths, talents, experiences, and relationships to navigate multiple aspects of their involvement in international research. The use of familial capital is apparent in the supportive communities that undergirded their sense of belonging and offered a representation of successful STEM professionals. At their undergraduate institutions, social capital, linguistic capital, and navigational capital emerge through their relationships with mentors, peers, research groups, and STEM-related organizations about their desired educational goals. Given the inherent challenges for women and minorities in STEM, their ability to advocate for their needs and rise above their trials to accomplish their goals signals the utilization of their resistant capital and aspirational capital. Their ability to employ their community cultural wealth reinforced their commitment to their goals, self-efficacy, and outcome expectations. Therefore, this work concurs with existing research on a global study that international research experiences can contribute substantially to the holistic development of women of color in STEM disciplines.1−7,10

Second, the findings illuminate the value of international research on participants’ intercultural awareness and growth to answer the second research question. Before the experience, all of the participants only engaged in research in the United States. Although participants’ experiences vary by location and duration, each participant indicated that the conducting research internationally afforded them a unique immersion opportunity in a different country and engaged with peers from diverse backgrounds. Like prior research on global experiences, students’ participation in international study travel developed a heightened awareness of diverse cultures and backgrounds. In the research study described here, participants discussed at length how engaging in research internationally expanded their perspectives about research activity and collaboration outside of the United States.

Through reflecting on their experiences, the findings reported here described how women of color actualized their identity as scientists. For many of the participants, engaging in international research substantially impacted their research skills and abilities. Each participant discussed the specific research and technical and professional skills they gained as a benefit of this experience. Most notably, the international research experience supported the development of their self-efficacy through various experiential opportunities within their field. For example, several participants had a chance to visit communities to educate underserved populations on public health concerns in Africa. These opportunities served as motivation to pursue their career goals and affirmed their sense of purpose in STEM. Aligned with the SCCT model, the findings suggest that the international research experiences, despite some challenges, benefited women of color in building self-efficacy and actualizing their outcome expectations.

**LIMITATIONS**

The present study presents the experiences of nine women across four different international research experiences. A majority of these women were chemistry majors. The variation in program duration, focus, structure, and location across the four international research experiences presents a possible limitation in this research study. Their international research experience not only focused on laboratory-based research but also included community public health outreach training for some participants. Another potential limitation is the variation in the participants’ time removed from their international research experiences. The variation in the time since the international research experience ranged from 6 months to 10 years. Participants who recently completed their international research experience were able to recall more details. At the same time, those further removed could describe the impact of their international research experience on their graduate studies and career pursuits. Thus, participants’ experiences are not presented comparatively but are presented as individualized experiences that highlight the similar themes and opinions of women of color from underrepresented groups in STEM.

**IMPLICATION**

The findings of this study have significant implications for universities and, more specifically, STEM academic departments, as they aim to retain women of color and produce successful graduates prepared for the job market and postbaccalaureate studies. First, participants shared that they learned of international research opportunities from mentors or peers in their STEM-related clubs and organizations. We encourage faculty and STEM leadership engaged in developing international experiences for students to utilize marketing strategies that directly use student organizations as an avenue to promote the benefits of international research opportunities. Further, we recommend to faculty and STEM leadership to leverage their professional networks and collaborations to better integrate international research opportunities into the academic curriculums of the STEM degree programs to increase access to
these novel experiences to all qualifying students. This may be accomplished using several collaborative mechanisms that strategically build relationships with international collaborators such as holding joint lectures, developing bilateral student exchanges, creating research internships, etc. We posit that this investment in STEM students will cultivate their individual personal and professional development and enhance their appeal on the job market.

Second, several students believed that international research experiences were unattainable opportunities because of the significant financial commitment needed to live abroad for an extended period. Without the guidance of a mentor, they would have overlooked this opportunity because of the financial barrier. We urge STEM faculty and departments to seek financial support from various federal, state, and local agencies such as the National Science Foundation to decrease the financial barrier for qualifying students. We also encourage faculty and STEM leaders to share funding mechanisms such as Boren Awards for International Study, the Fulbright US Student Program, Indigenous Biocultural Exchange (IBEX), the Benjamin A. Gilman International Scholarship, the Chautauquan Fellowship Program, and many more. Herein, faculty could share funding opportunities and develop student training opportunities to prepare for an international experience. Lastly, this study has important implications for faculty and staff working directly with women of color in STEM academic programs. Depending on the institutional context, some students were aware of race and gender inequities while others were not. Given the realities of the overall STEM landscape for women and minorities, it is increasingly crucial for STEM faculty and staff to prepare their students holistically for the potential barriers they could face. Also, women of color utilized their various forms of cultural capital to navigate their academic experience. Thus, the authors encourage STEM departments to cultivate specialized support spaces such as living—learning communities, mentoring, and affinity student organizations for this subpopulation.

The aforementioned recommendations, when taken in concert, have the potential to provide solid opportunities to increase student engagement in international activities. Moreover, these strategies would prepare students engaging in these activities with a solid foundation for having holistically positive experiences while abroad.

ASSOCIATED CONTENT

Supporting Information

The Supporting Information is available at https://pubs.acs.org/doi/10.1021/acs.jchemed.1c00518.

WoC Interview Protocol outlining the interview questions for this research study (reviewed and approved by the LSU Institutional Review Board) (PDF, DOCX)

AUTHOR INFORMATION

Corresponding Author

Zakiya S. Wilson-Kennedy — Department of Chemistry and College of Science Office of Diversity and Inclusion, Louisiana State University, Baton Rouge, Louisiana 70803, United States; orcid.org/0000-0002-8154-8574; Email: zwilson@lsu.edu

Authors

Raeshan D. Davis — School of Education, Louisiana State University, Baton Rouge, Louisiana 70803, United States; orcid.org/0000-0003-1135-208X

Leyte Winfield — Department of Chemistry, Spelman College, Atlanta, Georgia 30314, United States; orcid.org/0000-0003-3719-5895

David Spivak — Department of Chemistry, Louisiana State University, Baton Rouge, Louisiana 70803, United States

Complete contact information is available at: https://pubs.acs.org/10.1021/acs.jchemed.1c00518

Notes

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