Paper ID #40773

Enhancing the Cultural Competence of K-12 STEM Teachers through a Global Research Experience

Dr. Margaret Pinnell, University of Dayton

Dr. Margaret Pinnell is a professor in the Department of Mechanical and Aerospace Engineering at the University of Dayton.

Dr. Leanne Petry, Central State University

Dr. Leanne Petry is a Materials Engineer and Professor in the College of Engineering, Science, Technology, and Agriculture (CESTA) at Central State University (CSU). Her expertise is in analytical and materials characterization techniques, including microscopy, spectroscopy, chromatography, and electrochemistry. Her research interests include oxidation-reduction reactions at the surface of electrodes for sensor applications, corrosion mechanisms of materials, as well as their electrochemical degradation. She currently serves as the American Association of University Professors (AAUP) – CSU Chapter President, the Director of Faculty Development in the Center for Teaching and Learning (CTL) as well as Chair of the Diversity, Equity and Inclusion (DEI) Council at CSU. She advocates for the incorporation of high impact practices such as problem-based learning into educator lectures, laboratories, and outreach activities to engage students and the community in the education process, particularly STEM education.

Kelly Bohrer, University of Dayton

Kelly Bohrer is the Executive Director of the ETHOS Center, a community engagement center connecting students, faculty, and staff with NGOâ€™s around the world for technical projects as part of immersions, teaching, and scholarly activity. She also is th

Dr. Kellie Schneider, University of Dayton

Kellie Schneider is an Associate Professor in the Department of Engineering Management, Systems, and Technology at the University of Dayton. Prior to joining the faculty at UD, she was an instructor in the Freshman Engineering Program at the University of Arkansas. Her research interests are in the areas of engineering education and community-based operations research.

Mrs. Marjorie Langston Langston

Engagement in Practice: Involving Teachers in International Community Engaged Learning Projects to Enhance Their Understanding of Engineering and Intercultural Awareness

Abstract

Intercultural competence has become a critical skill for most professions, but particularly for those that involve working with people from diverse backgrounds. Teachers at all levels need intercultural competence to ensure that every student in their classroom has equitable access to learning and to effectively prepare their students to engage in an increasingly diverse and multicultural world. The United States Department of Education has made broader global skills for students a priority and has charged colleges and schools with providing new learning opportunities and course work to successfully develop these skills in teachers. Similarly, some argue that international travel is integral to teacher preparation, encouraging a sense of "otherness" and developing an appreciation for the role of human difference, addressing misconceptions and stereotypes, and challenging teachers' understanding of their "professional self." Additionally, it is well established that the US has a need for enhanced participation and increased racial and gender diversity in the STEM fields, particularly engineering. Teachers are critical to inspire and motivate students to consider pursuing STEM. However, stereotypes and bias can impact how teachers engage with students, and who teachers believe "has what it takes to be an engineer" leading to differentiated support and encouragement to excluded identities. Enhancing the cultural competence of teachers can help mitigate the bias and stereotypes, and help ensure more equitable access for students to being inspired to pursue STEM. To address these issues, two universities collaborated on a National Science Foundation Research Experience for Teachers grant to provide transformative international and intercultural experiences for teachers focused on human-centered design and appropriate technology for developing countries. Integrated throughout this experience was professional learning aimed at developing the cultural competence of the teachers, and coaching to help the teachers integrate this learning, as well as their engineering experiences, into their classrooms. This paper will summarize key findings from the second cohort participants with a focus on how this experience impacted the cultural competence of the participants.

Introduction

A recent report by the National Science Foundation (NSF), *The State of U.S. Science and Engineering 2022,* provides an overview of critical metrics used to evaluate the state of Science and Engineering in the United States (US). This publication reports that the US has slipped as a world leader in Science, Technology, Engineering and Mathematics (STEM) (National Science

Foundation, 2022). Among the nine indicators cited in this report, two are directly related to equity gaps that exist in K-16 education: (1) the underrepresentation of Blacks and Hispanics receiving science and engineering bachelor's degrees, and (2) disparities in K-12 STEM education and student achievement among different demographic and socioeconomic groups and geographic regions (National Science Foundation, 2022).

The challenge of increasing the number of students interested in pursuing STEM, particularly students from excluded identities, is complex and multifaceted, and includes both external factors such as access to experiences and educational opportunities, and intrinsic psychological factors such as identity, self-efficacy, sense of belonging and value perception (Allen, 2022; Anderson & Ward, 2014; Collins, 2018; Kricorian, Seu, Lopez, Ureta & Equils, 2020; Jackson, Mohr-Schroeder, Bush, Maiorca, Roberts,Yost & Fowler, 2021). The interrelated external and intrinsic factors that guide a student to or away from developing an interest in STEM careers are impacted by numerous facets of the student's identity and life as well as deeply rooted cultural, racial and gender stereotypes centered around STEM and who is believed to have the potential to be successful in a STEM field (Allen, 2022; Bryn & Allexsaht-Snider, 2008; Farinde & Lewis, 2012; Killpack & Melon, 2016; Tytler, 2014).

Teachers play a significant role in helping students develop an awareness of and interest in different career opportunities (Maltese, Melki & Wiebke, 2014; Vedder-Weiss & Fortus, 2012). Research shows that teachers also have an impact on a student's self-efficacy, STEM identity, sense of belonging, and outcome expectations which can influence the student's choice to pursue a STEM career (Allen, 2022; Bryan & Guzey, 2020; deBrey, Musu, McFarland, Wilkinson-Flicker, Diliberti, Zhang, Branstetter & Want, 2018; Tytler, 2014). Teachers impact a student both by the content that they teach, and how they teach and interact with their students. Unfortunately, teachers face many barriers when trying to integrate STEM into their classrooms. These barriers include the required shifts in pedagogy when teaching STEM, curricular restrictions and challenges, school structures such as class scheduling and a lack of administrative and financial support, student concerns such as a lack of student interest or perceived ability in STEM, assessment concerns, and the perception of teachers that they lack knowledge in STEM subject matter content and careers (Bryan, & Guzey, 2020; Margot & Kettler, 2019). These barriers impact a teacher's ability to expose their students to STEM.

Barriers and challenges that may limit a student's exposure to STEM are compounded by the fact that teachers have biases and stereotypes at the same level as the rest of the American population which can lead to disparate treatment and expectations of students. Implicit bias and stereotypes held by teachers can impact how teachers engage with their students, particularly around academic abilities and outcome expectations. This differential engagement by teachers with their students can have a direct impact on many of the intrinsic psychological factors that lead a student to or away from a particular career (Allen, 2022; de Brey, Musu, McFarland, Wilkinson-Flicker, Diliberti, Zhang, Branstetter & Wang, 2019; Starck, Riddle, Sinclair & Warikoo, 2020)

Therefore, in addition to developing a deeper understanding of STEM concepts and careers, teachers need skills and strategies to recognize and address implicit bias and stereotypes in their classroom by intentionally working to develop greater intercultural competence as well as culturally responsive pedagogy (Howard, Overstreet, & Ticknor 2020; DeJaeghere & Cao, 2009). This is particularly important given projections that the US expects significant growth in the number of Asian, Hispanic, new American population, and Black students over the next quarter of a century creating even more diverse classrooms in our schools (Passel & Cohn, 2008). Jackson, et al (2021) point out the importance of fostering STEM literacy and interest in students from all backgrounds through equitable access to high-quality, integrated STEM experiences. They go on to state that providing these experiences is a way to "disrupt the systems of oppression" by removing barriers to participation in high paying in demand STEM jobs (Jackson, Mohr-Schroeder, Bush, Maiorca, Roberts, Yost, & Fowler, 2021). Furthermore, if the US is to reestablish themselves as leaders in STEM and meet future workforce needs, it needs to ensure that ALL students are inspired in STEM, equity gaps are closed with regards to students' access to high quality STEM experiences, and it taps into the innovation, creativity and brilliance that can only be realized through diversity of thought and perspectives (Allen, 2022; Jones, 2020; National Center for Science and Engineering Statistics (NCSES), 2023). Therefore, the changing demographics in the US require teachers to have greater intercultural competence in order to effectively and more equitably teach and inspire a more diverse student body to consider STEM as a viable career path (Jackson, Mohr-Schroeder, Brush, Maiorca, Roberts, Yost & Fowler, 2021). In fact, Tehee, Isaacs and Domenech Rodríguez, (2020) view intercultural competence of teachers as one of four key dimensions required to create more equitable classrooms.

Although there are many definitions, Hammer (2015, p. 483) defines intercultural competence as "the capability to shift one's cultural perspective and appropriately adapt behavior to cultural differences and commonalities". Teachers who have a high level of intercultural competence employ an asset-based approach with regards to cultural differences (Pierre, Rathee & Rathee, 2021). Okken, et al (2015) present three competencies of intercultural competence for teachers: foundational, facilitation, and curriculum design. Embedded in these competencies are behaviors such as openness, social initiative, differentiation, communication skills, student centered learning, creativity, and classroom management (Okken, Jansen, Hofman & Coelen, 2022). Pierre, Rathee, and Rathee, (2021, p. 326) point out that:

> *Culturally competent teachers create caring learning communities where varied individual and cultural heritages including languages are freely expressed and highly valued. They utilize cultural and individual knowledge about their students, their families, and their communities to design effective instructional strategies that build upon and link the home*

and school experiences of the students. This is in addition to utilizing images, literature, and other forms of expression that represent students' diverse cultures and backgrounds. Culturally, competent teachers understand, affirm, and use students' home, primary languages, communication styles, and family structures for learning and discipline (Yamada, 2010). They challenge stereotypes, intolerance, and solidify the importance of cultural diversity through scientific and data-driven discourse. Culturally competent teachers serve as effective change agents by providing critical knowledge and acting in the school system as well as outside to address the inequities distinguished by (but not limited to) race, language, culture, socioeconomics, family structure, and gender (Min et al., n.d.).

Numerous other authors have also published on the importance of developing intercultural competence in teachers to more effectively and equitably teach a diverse group of students, and to equip teachers to better prepare their students to work in an increasingly multicultural world (Charity Hudley & Mallinson, 2017; Cushner & Chang, 2015; He, Lundgren & Pynes, 2017; Myles, 2019; Okken, Jansen, Hofman & Coelen, 2022;Walters, Garii and Walters, 2009; DeJaeghere & Cao, 2009).

Several strategies have been employed to help teachers and pre-service teachers develop their intercultural competence with mixed results. Among these strategies include professional development workshops grounded in theories of multicultural education and culturally supportive teaching, and short term (2-3 weeks) or long term (4 months - 1 year) teacher exchange or study abroad programs (Cusher & Chang, 2015; Okken, Jansen, Hoffman & Coelen, 2022; He, Lundgren & Pynes, 2017; Charity Hudley & Mallinson, 2017). Cushner & Chang (2015) used the Intercultural Development Inventory (IDI) to study the efficacy of eight to fifteen-week international student teaching. The IDI is a theory-based assessment tool that is used to measure either an individual or group's mindset and skill set related to intercultural interactions along a developmental path (https://www.idiinventory.com/). Using this tool, Cushner & Chang (2015) found that the participants had some positive developmental growth in their intercultural competence, but the change was not significant.

He, Lundgren and Pines (2017) describe a program for experienced teachers where the teachers engaged in a pre-departure course, a four-week program in China, and a follow-up curriculum design and delivery activity. These researchers used the IDI to assess participants' gains, as well as other qualitative methods including ongoing reflections, and an assessment of the participants' curriculum design projects. Similar to Cushner and Chang (2015), He Lundgren and Pines (2017) did not see dramatic growth on the IDI, but did see some positive changes in the participants' beliefs, insights, and teaching practices.

Using a different assessment strategy, Oken, Jansen, Hoffman and Coelen (2022) found international experience to have a significant positive impact on developing the intercultural competence of teachers. Finally, Charity Hudley, and Mallinson, (2017) found their professional development workshops, grounded in theories of multicultural education and culturally supportive teaching, to be effective in developing the intercultural competence of teachers.

Program Description

The University of Dayton (UD) and Central State University (CSU) received a three-year collaborative National Science Foundation Research Experience for Teachers (NSF RET) grant entitled Collaborative RET Site – Global STEM – Appropriate Technology for Developing Communities (Global STEM). The overarching objective of this grant was to provide a transformative research and international experience for current and future teachers that increases their intercultural awareness and exposes them to the integrative nature of engineering and the social impact that engineering has in our world. This paper will summarize Year 2 of the three-year grant with a special emphasis on the impact this program had on advancing the intercultural competence of the participants.

The Global STEM program had five distinct components: (1) Intercultural competence and travel preparation; (2) Appropriate technology related research and/or human-centered design that supports the work of an international community partner under the mentorship of a faculty member at one of two regional universities; (3) On-site work at the international community partner's facility; (4) Two-week intensive curriculum development with the participant cohort under the guidance of a curriculum coach; and (5) Follow-on programming that includes continued research with a faculty member as well as piloting, revising, and final submission of curriculum to TeachEngineering. Although unique to any of the programs described above, the Global STEM program included similar components to those described by He, Lundgren and Pines (2017) such as the pre-departure course, approximate length of the international immersion, and follow-up curriculum design and delivery activities.

In order to ensure that the Global STEM program employed research based best practices related to intercultural competence development, international immersions and fair trade learning, it partnered with UD's Ethos Center to develop and facilitate 33 hours of participant pre-departure orientation sessions over the course of seven days, that included cultural orientation, intercultural competence development sessions, health, safety and travel information and technical preparation (Hartman, Paris, & Blache-Cohen, 2014; Lough & Toms, 2018). Additionally, the participants and program facilitators engaged in the Global Up Global Competence Certificate (GCC) online learning opportunity offered through AFS Intercultural Programs (https://afs.org/Certificate) before, during and after the participants' two to three-week international immersions. All of the technical preparation was centered around concepts of human-centered design and appropriate technology. The participants engaged with their faculty mentors on research experiences related to the United Nations Sustainable Development Goals (https://sdgs.un.org/goals) that aligned with the work of their community partner placements. In late June or early July, the Global STEM participants traveled internationally in small groups to their assigned community partner site for two to four weeks where they engaged in engineering research and design activities.

Upon their return, the participants engaged in an intensive, two-week curriculum development workshop under the guidance of a curriculum coach. During the 2023-2024 school year, the in-service teachers from the 2023 cohort will pilot their curriculum in their classroom and then revise, edit and submit their curriculum for publication to TeachEngineering.

Participants:

Twelve participants were recruited for the Summer 2023 Global STEM, including three pre-service teachers, and one participant who served in a non-traditional teacher role. One teacher participant dropped out of the program prior to the start of the orientation sessions, and one participant was not able to travel internationally and was therefore placed with a domestic community partner for their immersion. Of the eight participating teachers, two taught science or engineering at the high school level, one served in a non-traditional teaching role at a high school, four taught science, math or engineering in grades 3 - 8, and one taught social studies at the elementary school level. The participant placements are shown below in Table 1.

Table 1 – Global STEM Participant Placements

Partner Organization	Location	Engineering Project
Etta Projects	Bolivia	Engineering design of dry, ecological bathrooms, and use of medicinal plants, and aquaponics
United Rehabilitation Services	Dayton (US)	Analysis and use assessment of assistive and educational devices.
Alhassan Foundation	Egypt	Design of personalized wheelchairs for differently abled persons.
Academic City	Ghana	Sustainable engineering design for waste management using laser printing and 3D printing
SELCO Foundation	India	Engineering solutions for energy independence to improve health and livelihood in marginalized communities.

Research Question and Methods:

Although the Global STEM program had four objectives, this paper focuses on one key objective: RET participants will develop greater intercultural self-awareness and an understanding of how cultural norms affect engineering design and the adoption of engineering innovations. Specifically, participants will: Increase their self-knowledge of intercultural competence, and explore and adopt strategies for developing their own intercultural effectiveness; Explore and evaluate engineering innovations within a framework of community wellbeing and sustainable development; Integrate cultural knowledge, ideas and concepts into STEM curriculum and pedagogy. Therefore this paper will focus on the research question: "Does participation in the NSF RET Global STEM program positively impact participants' intercultural competence?"

In an effort to address this research question, a convergent parallel mixed method evaluation design (Creswell & Plano, 2007) was employed. Qualitative and quantitative data were collected during the entire program and weighted equally. The two types of data were collected to document and assess successes and challenges for the 2023 cohort.

Quantitative Assessment: Participants completed both the IDI, described above, and the Intercultural Effectiveness Scale (IES) at the start of the program in January 2023 and then again in July 2023 after returning from their immersion. The IDI is a statistically reliable and cross-culturally valid measure of intercultural competence. It is a 50-item questionnaire with responses to statements made on a five-point agree-disagree scale. It has been psychometrically tested and determined to be a robust cross-culturally generalizable, valid and reliable assessment of an individual's or group's core orientations toward cultural difference (Hammer, 1999, 2007, 2009; Hammer et al., 2003; Paige, Jacobs-Cassuto, Yershova, & DeJaeghere, 2003). Validation of the IDI is based on confirmatory factor analysis, reliability analysis, and construct validity tests. The IDI offers three measures. The first is the Perceived Orientation (PO), or where an individual believes they fall on the continuum. The second is the Developmental Orientation (DO), or where the individual's answers on the IDI indicate they actually are on the developmental continuum. The difference between these two numbers is called the Orientation Gap (OG).

The IES was developed and validated to measure an individual's behavioral ability or intercultural effectiveness in intercultural interaction. Based on a review of global leadership competencies, the IES is used in contexts such as those found in many educational settings, where economy and ease of administration are critical program elements. The IES (Mendenhall, Stevens, Bird, Oddou & Osland, 2011) consists of three domains: Continuous Learning, Interpersonal Engagement, and Hardiness. Each of these competencies can be broken down into sub-competencies, which are important aspects of intercultural competency. Factor analysis for each subscore grouping resulted in a coefficient alpha reliability of between 0.79 to 0.84 (Mendenhall, Stevens, Bird, Oddou & Osland, 2008).

Qualitative Assessment: Qualitative data was collected at the conclusion of each orientation session, weekly throughout the immersion experience, upon return from the immersion, and after the developed lesson was piloted in the classroom. Participants completed online surveys to collect feedback on the orientation sessions as well as feedback during the immersion. Orientations, curriculum sessions, and participant presentations were observed and, in some cases, recorded. Following the curriculum development and pilot, qualitative data were collected using a semi-structured interview protocol.

Results and Conclusions:

Results of the pre and post IDI data for the 11 participants is summarized below in Table 2.

Table 2. Pre and Post IDI Data for RET Participants

Part.	Pre PO Score	Post PO Score	Pre PO Name	Post PO Name	Pre DO Score	Post DO Score	Pre DO Name	Post DO Name	OG
1	116.43	123.37	Acc	Acc	83.97	99.08	Pol	Min	32.46
2	116.87	127.39	Acc	Acc	85.04	110.54	Min	Min	31.83
3	110.53	114.33	Min	Min	64.53	71.37	Den	Pol	46.00
4	117.93	128.98	Acc	Acc	86.65	117.55	Min	Acc	31.28
5	115.23	118.75	Acc	Acc	75.56	78.97	Pol	Pol	39.67
6	120.95	125.84	Acc	Acc	94.84	105.55	Min	Min	26.11
7	124.10	131.91	Acc	Adp	99.45	114.04	Min	Min	24.65
8	132.48	128.08	Adp	Acc	121.53	104.38	Acc	Min	10.95
9	132.39	133.48	Adp	Adp	119.75	121.39	Acc	Acc	12.64
10	123.06	124.78	Acc	Acc	95.77	99.58	Min	Min	27.29
11	121.22	125.63	Acc	Acc	89.80	97.97	Min	Min	31.42
Avg Cohort	*121.02*	*125.69*			*92.44*	*101.86*			*28.57*

The overall average PO and DO scores increased and the OG decreased, as predicted. The cohort average scores were found to be within the same developmental orientation of Acceptance and Minimization respectively. Based on a paired, two tail t-test, the changes in the PO and DO scores represent a significant difference from pre to post (PO p=0.0342, DO p=0.0057, OG p=0.091) indicating that the program had a positive impact on the participants intercultural competence. Of the eleven individuals who completed the program, the IDI scores for four participants shifted developmental levels. Three of those increased from polarization to minimization, denial to polarization, and minimization to acceptance. One participant's developmental level decreased from acceptance to minimization. This same participant's perceived orientation also decreased one from adaptation to acceptance.

As described above, the participants took the IES pre-program orientation, and then again upon completion of the travel and curriculum workshop. Results of the IES for the Global STEM cohort 2 participants are provided below in Table 3. The matched-pairs analysis indicates that there were increases in each of the domains and sub-competencies. However, the only domain that indicates a significant difference between pre and post assessment was Continuous Learning, or how a person learns about people and the accuracy of that learning. Continuous Learning has two sub-competencies. First is self-awareness or the degree to which an individual is aware of personal values, strengths, weaknesses, interpersonal style, and behavioral tendencies, as well as their impact on others. The second is exploration or openness to understanding ideas, values, norms, situations, and behaviors that are different from one's own. A similar change was noted for both sub-competencies. One factor that may have contributed to the lack of a significant difference between the pre and post IES scores, is that the RET participants had a relatively high intercultural competence at the beginning of the program which could account for the small change in the IES results.

Qualitative observations, surveys, presentations, and interviews were valuable in recording the participants' voices and evidence of personal growth. Throughout orientation sessions, participants reflected deeply on the GCC topics with survey questions coordinated with the session content, like self-awareness, dealing with conflict, and growth mindset. After each session, participants shared an appreciation for the mentally challenging exercises and learning about different perspectives. Immersion narratives written by participants throughout the travel experience had contextual themes of continued self-awareness, heightened cultural awareness, and identifying the cultural components of engineering. During individual interviews, participants reported on the curriculum pilot in classrooms, identifying successes, improvements, and student engagement. Finally, travel teams will present presentation posters to interested parties and the next cohort of participants to share the most impactful parts of the program.

Results from the quantitative and qualitative data suggest the RET program, including pre-travel orientation sessions, the GCC, and engagement with a diverse community partner, had a positive impact on the intercultural competence of the participating in-service and pre-service teachers. The intentional partnership between the program participants and embedded community partners, especially for those participants that traveled to international locations working within the communities, amid foreign languages and unfamiliar customs, was a significant component of this program. Additionally, the GCC has been found to increase intercultural competence and since the RET participants also completed the GCC it may have contributed to the increase in post assessment scores (Bittenger, 2019). Further, since the RET participants engaged in a variety of different activities aimed at increasing their intercultural competence, it is impossible to assess if any one specific activity had an impact, or if the combination of activities over the six months they engaged in the program had an impact.

Table 3. RET Participants Pre and Post IES results

Domain	Pre	Post	Change	P Value
Continuous Learning	*5.55*	*5.95*	*.40*	*.031*
Self-Awareness	5.31	*5.72*	*.40*	*.057*
Exploration	5.76	*5.78*	.39	*.056*
Interpersonal Engagement	*4.95*	5.33	.38	.300
World Orientation	4.19	4.53	.34	.549
Relationship Development	5.60	6.03	.42	.140
Hardiness	4.88	5.20	.32	.144
Positive Regard	5.20	5.67	.47	.096
Emotional Resilience	4.56	4.74	.18	.434
Overall IES	**5.14**	**5.51**	**.37**	**.071**

Comparing the results of the Global STEM Program to a that described by He, Lundgren and Paynes (2017), the Global STEM Program was found to have similar outcomes. As mentioned above, the program described by He, Lundgren and Paynes (2017) included many of the same components of the Global STEM Program such as pre-departure workshops, a shorter-term immersion, and curriculum development. Although the program described by He. Lungdren and Paynes did not see dramatic growth on the IDI, they did see some positive changes in the participants' beliefs, insights, and teaching practices, similar to what was found in this study.

Study Limitations

Several limitations inherent to the research design and contextual constraints are acknowledged. The main limitation of this study is the small sample size of participants. As a pilot program, the small sample size was purposeful, allowing a manageable number of travelers to coordinate and support through the immersion and curriculum development, but the small cohort numbers limit the influence of the quantitative assessments.

Additionally, another primary challenge faced during this study was difficulty in identifying suitable sites for participant placements with international community partners. The scarcity of established international partner organizations that align with program criteria of clear engineering impact, and who have the bandwidth to host program participants, posed a significant challenge. Consequently, the findings might not encompass a diverse range of organizations, potentially limiting the generalizability of the results. Similarly, the issue of scaling these international placements remains a significant hurdle. While this study provides valuable insights into the challenges faced, the strategies for scaling these programs effectively require further exploration. The complexities of expanding such programs to accommodate larger cohorts of teacher participants were beyond the scope of this research and necessitate in-depth investigation in future studies.

Furthermore, engaging participants who are open to cultural discovery, growth, and self-awareness proved to be a multifaceted challenge. While efforts were made to select participants who demonstrated openness to these experiences, the varying degrees of cultural adaptability and self-awareness among participants introduced a layer of complexity to this study. This variability might have influenced the outcomes and should be considered in the interpretation of the results.

Lastly, the findings of this study are subject to the specific characteristics and dynamics of the 2024 cohort. The small sample size, a consequence of project funding and scope, raises questions about the generalizability of the results. Future research endeavors should aim to include larger and more diverse samples to validate and extend the findings, ensuring a comprehensive understanding of the challenges and opportunities associated with international placements for teachers in engineering-focused organizations.

Next Steps: Building on Success in Year Three of the NSF RET Program

Using the IES and IDI data for cohort 2, along with feedback from the RET participants, several changes will be made to Global STEM program to better ensure that the participants have opportunities to grow their cultural competence. In particular, the international immersions, a central component of the program, will be modified where all of the participants will travel as a larger group. The participants will engage in home stays through an organization that employs ethical and effective practices of engaging with indigenous communities. This immersive journey will provide participating educators with exposure to STEM practices in a global context, facilitating collaboration with communities and engineers from around the world. The goal is to offer an authentic international experience that fully integrates culturally immersive activities, while also minimizing some of the distractions the participants faced when traveling in small groups. The participants will engage in engineering work in the local communities and learn about engineering practices and sustainable technology use in that country. Other aspects of the program such as intercultural development sessions, including the GCC, will continue as they did this year. These sessions will equip teachers with the skills needed to navigate diverse environments and promote inclusivity within their STEM classrooms.

In conclusion, as the Global STEM program embarks on its final year with its third cohort of teachers, the focus remains on providing a rich experience to develop the intercultural competence of teachers. The integration of international immersion experiences and intercultural development underscores the commitment to preparing educators for the challenges and opportunities of the 21st century. The program looks forward to continuing its journey toward enhancing STEM education and leaving a lasting impact on teachers, students, and communities.

Acknowledgements

This collaborative effort in materials and manufacturing is supported in part by the National Science Foundation under Grant Numbers EEC-1855231 and EEC-1855239. Any opinions, findings, and conclusions or recommendations expressed herein are those of the authors and do not necessarily reflect the views of the National Science Foundation.

References

Allen, T. G. (2022) Young, Gifted and Missing, Diversity in Higher Education, 25, 163–181 Copyright © 2022 Tawannah G. Allen Published under exclusive licence by Emerald Publishing Limited ISSN: 1479-3644/doi:10.1108/S1479-364420220000025012

Andersen, L. and Ward, T.J. (2014), Expectancy-Value Models for the STEM Persistence Plans of Ninth-Grade, High-Ability Students: A Comparison Between Black, Hispanic, and White Students. Sci. Ed., 98: 216-242. https://doi.org/10.1002/sce.21092

Bittinger, M (2019). An Instructor's Experiment: Adding Intentional Global Competency into a Pre-Existing Short-Term Study Abroad Program. (Version 2.0), accessed at https://hubicl.org/publications/49/2

Bryan, L., & Guzey, S. S. (2020). K-12 STEM Education: An Overview of Perspectives and Considerations. Hellenic Journal of STEM Education, 1(1), 5–15. https://doi.org/10.51724/hjstemed.v1i1.5

Bryan, L., & Allexsaht-Snider, M. (2008). Community and classroom contexts for understanding nature and naturally occurring events in rural schools in Mexico. L1-Educational Studies in Language and Literature, 8(1), 43–68. https://doi.org/10.17239/L1ESLL-2008.08.01.06

Collins, K. H. (2018). Confronting Color-Blind STEM Talent Development: Toward a Contextual Model for Black Student STEM Identity. Journal of Advanced Academics, 29(2), 143–168. https://doi.org/10.1177/1932202X18757958.

Charity Hudley, A. H., & Mallinson, C. (2017). "It's worth our time": A model of culturally and linguistically supportive professional development for K-12 STEM educators. Cultural Studies of Science Education, 12, 637-660.

Cushner, Kenneth & Chang, Shu-Ching. (2015). Developing intercultural competence through overseas student teaching: Checking our assumptions. Intercultural Education. 26. 1-14. 10.1080/14675986.2015.1040326.

de Brey C., Musu L., McFarland J., Wilkinson-Flicker S., Diliberti M., Zhang A., Branstetter C., Wang X. (2019). Status and trends in the education of racial and ethnic groups 2018 (NCES 2019-038). Washington, DC: National Center for Education Statistics. https://nces.ed.gov/pubs2019/2019038.pdf

DeJaeghere, J. G., & Cao, Y. (2009). Developing U.S. teachers' intercultural competence: Does professional development matter? International Journal of Intercultural Relations, 33(5), 437–447. https://doi.org/10.1016/j.ijintrel.2009.06.004

Farinde, A. A., & Lewis, C. W. (2012). The underrepresentation of African American female students in STEM fields: Implications for classroom teachers. US-China Education Review B. 4, 421-430.

Hammer, M. R. (1999). A measure of intercultural sensitivity: The intercultural development inventory. In S. M. Fowler & M. G. Mumford (Eds.) The Intercultural sourcebook (pp. 1-18). Intercultural Press.

Hammer, M. R. (2007). The intercultural development inventory manual. IDI, LLC.

Hammer, M. R. (2009). Solving problems and resolving conflict using the Intercultural Conflict Style model and Inventory. In M. A. Moodian (Ed.), Contemporary leadership and intercultural competence: Exploring the cross-cultural dynamics within organizations (pp. 219-232).

Hammer, M. R., Bennett, M.J., & Wiseman, R. (2003). Measuring intercultural sensitivity: The intercultural development inventory. International Journal of Intercultural Relations, 27(4).

Hammer, M. R. (2015). Intercultural competence development. In J. M. Bennett (Ed.), The SAGE encyclopedia of intercultural competence. Thousand Oaks, CA: SAGE Publishing, Inc, pp 483-486.

Hargman, E, Morris, C & Blache-Cohen, B. (2014). Fair Trade Learning: Ethical standards for community-engaged international volunteer tourism. Tourism and Hospitality Research, 14(1–2), 108–116. https://doi.org/10.1177/1467358414529443

Hartman, E., Paris, C. M., & Blache-CoHammer, M. R. (2015). Intercultural competence development. In J. M. Bennett (Ed.), The SAGE encyclopedia of intercultural competence (pp. 483-486). Thousand Oaks, CA: SAGE Publishing, Inc

He, Ye & Lundgren, Kristine & Pynes, Penelope. (2017). Impact of short-term study abroad program: Inservice teachers' development of intercultural competence and pedagogical beliefs. Teaching and Teacher Education. 66. 147-157. 10.1016/j.tate.2017.04.012.

Howard, C. M., Overstreet, M. H., & Ticknor, A. S. (2020). Engaging Preservice Teachers with Culturally Responsive Pedagogy: Three Model Lessons for Teacher Educators. Journal of Language and Literacy Education: Take 2. http://jolle.coe.uga.edu/take-2/

Jackson, C., Mohr-Schroeder, M. J., Bush, S. B., Maiorca, C., Roberts, T., Yost, C., & Fowler, A. (2021). Equity-oriented conceptual framework for K-12 STEM literacy. International Journal of STEM Education, 8, 1-16.

Jones, Graham & Chace, Bernardita & Wright, Justin. (2020). Cultural diversity drives innovation: empowering teams for success. International Journal of Innovation Science. 12. 323-343. 10.1108/IJIS-04-2020-0042.

Killpack T. & Melón L. (2016). Toward Inclusive STEM Classrooms: What Personal Role Do Faculty Play? CBE Life Sci Educ. 2016 fall;15(3):es3. doi: 10.1187/cbe.16-01-0020. PMID: 27496362; PMCID: PMC5008899.

Kricorian, K., Seu, M., Lopez, D., Ureta, E. & Equils, O. Factors influencing participation of underrepresented students in STEM fields: matched mentors and mindsets. IJ STEM Ed 7, 16 (2020). https://doi.org/10.1186/s40594-020-00219-2

Lough, B. & Toms, C. (2018) Global service-learning in institutions of higher education: concerns from a community of practice, Globalisation, Societies and Education, 16:1, 66-77, DOI: 10.1080/14767724.2017.1356705

Maltese, A. V., Melki, C. S. & Wiebke, H. L. (2014). The nature of experiences responsible for the generation and maintenance of interest in STEM. Science Education, 98, 937–962. https://doi.org/10.1002/sce.21132

Margot, K.C., Kettler, T. Teachers' perception of STEM integration and education: a systematic literature review. IJ STEM Ed 6, 2 (2019). https://doi.org/10.1186/s40594-018-0151-2

Mendenhall, M. E., Stevens, M. J., Bird, A. L. L. A. N., Oddou, G. R., & Osland, J. S. (2011). Intercultural effectiveness scale: Technical report. Chesterfield: The Kozai Group Inc.

Min, M., Lee, H., Hodge, C. & Croxton, N. (n.d.). What Empowers Teachers to Become Social Justice-Oriented Change Agents? Influential Factors on Teacher Agency toward Culturally Responsive Teaching. Education and Urban Society, 0(0), 00131245211027511. https://doi.org/10.1177/00131245211027511 [cited in Pierre, et al 2021]

Myles, Johanne Mednick, (2019) What is intercultural competence and why is it important, Education Canada September, 2019. accessed from: https://www.edcan.ca/articles/developing-intercultural-competence/

National Science Board, National Science Foundation. 2022. Science and Engineering Indicators 2022: The State of U.S. Science and Engineering. NSB-2022-1. Alexandria, VA. Available at https://ncses.nsf.gov/pubs/nsb20221

National Center for Science and Engineering Statistics (NCSES). 2023. Diversity and STEM: Women, Minorities, and Persons with Disabilities 2023. Special Report NSF 23-315. Alexandria, VA: National Science Foundation. Available at https://ncses.nsf.gov/wmpd.

Okken, Grada & Jansen, Ellen P.W.A. & Hofman, W. & Coelen, Robert. (2022). Interculturally competent teachers: behavioural dimensions and the role of study abroad. Cogent Education. 9. 10.1080/2331186X.2022.2138048.

Paige, R. M., Jacobs-Cassuto, M., Yershova, Y. A., & DeJaeghere, J. (2003). Assessing intercultural sensitivity: An empirical analysis of the Hammer and Bennett Intercultural Development Inventory. International Journal of Intercultural Relations, 27(4).

Passel, J. S., & D'Vera Cohn, D. (2008). US population projections, 2005-2050 (p. 20). Washington, DC: Pew Research Center.

Pierre, Y., Rathee, N. K., & Rathee, V. S. (2021). Developing cross-cultural competency through multicultural perspective: An exploratory inquiry. European Scientific Journal, 17(27), 324-346.

Starck, J. G., Riddle, T., Sinclair, S., & Warikoo, N. (2020). Teachers are people too: Examining the racial bias of teachers compared to other American adults. Educational Researcher, 49(4), 273–284. https://doi.org/10.3102/0013189X20912758

Tehee, M., Isaacs, D., & Domenech Rodríguez, M. M. (2020). The elusive construct of cultural competence. In L. T. Benuto, F. R. Gonzalez, & J. Singer (Eds.), Handbook of cultural factors in behavioral health: A guide for the helping professional (pp. 11–24). Springer Nature Switzerland AG. https://doi.org/10.1007/978-3-030-32229-8_2

Tytler, R. (2014). Attitudes, identity, and aspirations toward science. In N. G. Lederman & S. K. Abell (Eds.), Handbook of research on science education (pp. 82–103). New York: Routledge. https://doi.org/10.4324/9780203097267.ch5

Vedder-Weiss, D. & Fortus, D. (2012). Adolescents' declining motivation to learn science: A follow-up study. Journal of Research in Science Teaching, 49(9), 1057–1095. https://doi.org/10.1002/tea.21049

Walters, L., Garii , B. & Walters, T. (2009) Learning globally, teaching locally: incorporating international exchange and intercultural learning into pre-service teacher training, Intercultural Education, 20:sup1, S151-S158, DOI: 10.1080/14675980903371050

Yamada, M. (2010). Building Racial and Cultural Competence in the Classroom: Strategies From Urban Educators by Karen Monheim Teel and Jennifer E. Obidah (Eds.). Diaspora, Indigenous, and Minority Education, 4(3), 208–210. https://doi.org/10.1080/15595690903227780 [cited in Pierre, et al 2021]