

## **Board 413: Towards an Understanding of the Impact of Community Engaged Learning Projects on Enhancing Teachers' Understanding of Engineering and Intercultural Awareness**

### **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.

### **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.

### **Dr. Margaret Pinnell, University of Dayton**

Dr. Margaret Pinnell is the Associate Dean for Faculty and Staff Development in the school of engineering and associate professor in the Department of Mechanical and Aerospace Engineering at the University of Dayton. She teaches undergraduate and graduate

### **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 NGOs around the world for technical projects as part of immersions, teaching, and scholarly activity. She also is the

### **Dr. Amy Anderson**

Amy Anderson is the Associate Provost for Global and Intercultural Affairs and Executive Director of the Center for International Programs (CIP) at the University of Dayton. The CIP provides coordination, strategic planning and administrative support for

**Elizabeth Generas**

**Mrs. Marjorie Langston Langston**

**Sharath Krishna**

## **Towards an Understanding of the Impact of Community Engaged Learning Projects on Enhancing Teachers' Understanding of Engineering and Intercultural Awareness**

### **Abstract**

Two regional universities have completed the first round of a three-year collaborative NSF Research Experience for Teachers grant focused on human-centered design and appropriate technology for developing countries. In this transformative research experience, teachers travel to global community partner sites to engage in learning projects aimed to enhance their understanding of engineering and intercultural awareness. Upon return from their immersion experience, the teachers complete an intensive, two-week curriculum development workshop. The teachers then pilot the resulting lesson(s) in their classroom, make revisions as necessary, and share their finalized curriculum with other STEM educators via the TeachEngineering website. Throughout the experience, teachers benefit professionally through integrated development activities and cultivate greater self-awareness and understanding of culture.

First, this paper will summarize the project to date. Then, we present observations from participants' reflections, semi-structured interview, and pre/post intercultural assessments. Next, we highlight the collaborative outreach and capacity-building efforts which resulted in a new community partner and immersion site. Finally, we discuss the unique opportunities and challenges associated with navigating international travel and immersion experiences during the COVID-19 pandemic.

### **Project Summary**

The Global STEM Research Experience for Teachers (RET) is a collaborative program between Central State University (CSU), the University of Dayton (UD), and local school districts. This program provides current and future teachers with transformative research and international experiences that express the integrative nature of engineering with other disciplines and the social impact of engineering in the world. A key component of this collaboration is the University of Dayton's Ethos Center. For more than 20 years, The Ethos Center has guided students through transformative immersion experiences with community partnerships in Dayton, Ohio, the United States, and around the world. The goal of an Ethos Center immersion is to expand the worldview of participants and empower them through experience and knowledge to become lifelong learners and advocates for social change.

Teachers play a significant role in helping students develop an awareness of, and interest in different career opportunities [1]. They also help shape a students' self-efficacy and expectations which can have a significant impact on the student's choice of careers [2]. Unfortunately, many teachers either have little knowledge of the field of engineering or have misconceptions about the field such as failing to identify engineering as a career that helps humanity [3-4]. Engineering Community Engaged Learning (CEL) is an excellent way to help teachers understand how engineering, as well as other STEM careers, can have a high level of community engagement while using creativity to help humanity.

For the 2022-2023 Global STEM cohort, RET participants engaged with Ethos Center community partners located in Vashon Island, WA, Bangalore, India, and Antigua, Guatemala. Teachers traveled from Dayton, Ohio, to their immersion site, where they spent approximately 80 hours on-site learning about appropriate technology such as clean cook stoves, assistive devices for visually impaired students, renewable energy, and sustainable agriculture. Additional information on the community partners and their work is provided below in Figure 1.



Figure 1. 2022-2023 Ethos Community Partners for RET Immersions

Upon return from their immersion experience, the teachers participated in an intensive two-week curriculum development workshop to develop lessons for TeachEngineering, a Digital Library resource. The teachers piloted their curriculum in their classrooms during Fall 2022, revised the lesson as needed, and submitted it to TeachEngineering (TE). Currently, 3 lessons have been accepted as follows:

- Accepted: Let's Play: Accessible Toys, TE 2760
  - Christina Cook, 8th grade STEM, Tri-Village School District (Ohio)
  - Nya McMullen, 12th grade math, Middle College High School (North Carolina)
- Accepted: Mechanized Farm Equipment, TE 2754
  - Justin Stout, 4th & 5th grade science, Wilmington School District (Ohio)
- Accepted: Clean Cooking Matters, TE 2764
  - DelMaria Watts, 8th grade STEM, Trotwood-Madison City Schools (Ohio)

## Methodology

A convergent parallel mixed method evaluation design [5] was used for evaluation. Qualitative (lessons, surveys, and interviews) and quantitative (intercultural assessments) data were collected and weighted equally. Audio data from interviews were transcribed and coded using a constant comparative analysis [6] based on themes predetermined according to project objectives as well as themes that emerged during the analyses, such as resources, content usefulness, time commitment, and activities in class. Similar analyses were implemented for the participant online survey responses. Trustworthiness methods [7] were included in the analyses such as member checks, literature reviews, research journal entries and triangulation to limit any aspects of biases

during the analyses. Assessment data from the intercultural assessments were analyzed as matched-pairs to determine significant differences in pre- and post-immersion experience.

## Participant Impact

Participants' self-reported feedback about their personal intercultural development and the intercultural competency assessments provided evidence that the participants did undergo a significant experience, which caused them to critically evaluate their own surroundings. Feedback data also included evidence of personal network development and considerations for leadership opportunities. The curriculum developed by participants, including the three lessons accepted by TeachEngineering, are evidence of the rich intercultural experience, translated into classroom learning opportunities. However, the wide range of curriculum development skills among the participants proved frustrating for some during the post-experience workshop.

## Intercultural Competency

In addition to developing a deeper understanding of engineering as an attractive career that helps humanity, teachers at all levels need enhanced intercultural competence that highlights the importance of intersectionality and how one's unique perspectives frame experiences when engaging across cultures. Intercultural awareness, communication and competence have become critical professional skills in today's global economy. Therefore, teachers need to have these skills if they are to guide their students to global competence [8-13]. For this program, pre-post data regarding the participants' cultural awareness and development is collected to capture the complexity of intercultural development. Specifically, the Intercultural Development Inventory (IDI) and the Intercultural Effectiveness Scale (IES) is used to assess participant growth in these areas [19, 23]. The IDI is a 50-item questionnaire with responses made on a 5-point agree-disagree scale [14]. The IDI 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 [15-20]. In comparison, the IES assesses three domains: Continuous Learning, Interpersonal Engagement and Hardiness broken into sub-competencies [21]. Figure 2 provides a graphical representation of the IDI and IES frameworks.

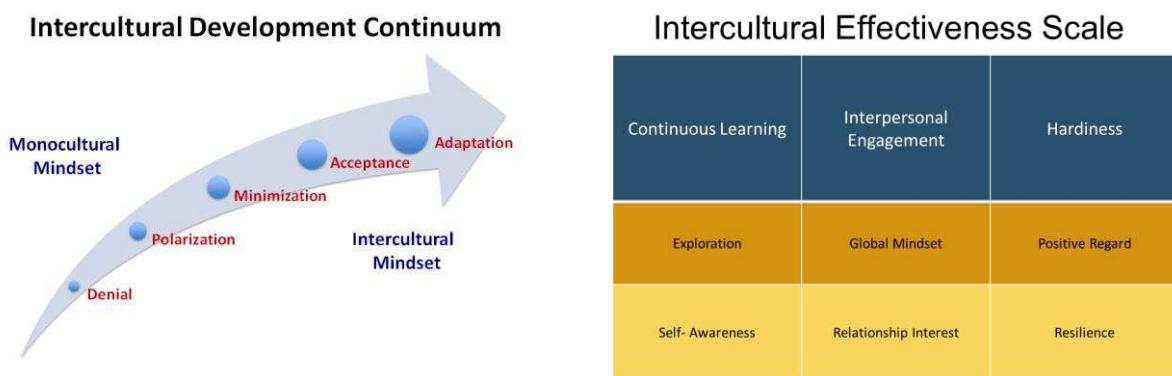


Figure 2. Frameworks to Assess Intercultural Development [19], [23]

Initial results from the pre-post IDI and IES assessments indicate an overall increase in the 2022-2023 cohort's intercultural development. Participants took the IES pre-program orientation, and then again upon completion of the travel and curriculum workshop. The matched-pairs analysis indicates that there were significant differences in overall intercultural effectiveness, and on each of the three domains. The only sub-competency that did not show significant difference between pre and post was in World Orientation, or the degree to which one is interested in other cultures and the people who live in them. World Orientation was the lowest sub-competency in the pre-test results. However, the overall domain of Interpersonal Engagement reflected significant growth due to strong gains in Relationship Development.

Results for the IDI were more mixed. Of the five individuals who completed the program, the IDI scores for three participants indicated a shift in developmental levels. One participant underwent an important intercultural developmental advance. Another participant experienced a shift indicating a stronger desire or goal toward intercultural competence. A third participant experienced a developmental regression. Regression is not uncommon for individuals who experience a developing economic environment for the first time. As a result, these individuals tend to look more critically at their culture and experience polarization as reversal. The other two participants remained in the same developmental stage.

### **Collaborative Outreach and Capacity-Building**

Ongoing collaborations among The Ethos Center and faculty at CSU resulted in the establishment of an international partnership with Vision Empower in Bangalore, India. This partnership advanced through the development of technology that has undergone multiple iterations of design-feedback-redesign and was tested in India with visually impaired students. Dr. Sharath Krishna, from CSU, served as the primary liaison between the research team and Ms. Supriya Dey, from Vision Empower. Additionally, Dr. Krishna provided in-country assistance to the Global STEM participants with placements in Bangalore. This community outreach and capacity building is exemplified in Figure 3 which illustrates the overarching goal of how the use of appropriate technology and human centered design in engineering research is built upon a foundation grounded by intercultural cultural competence.

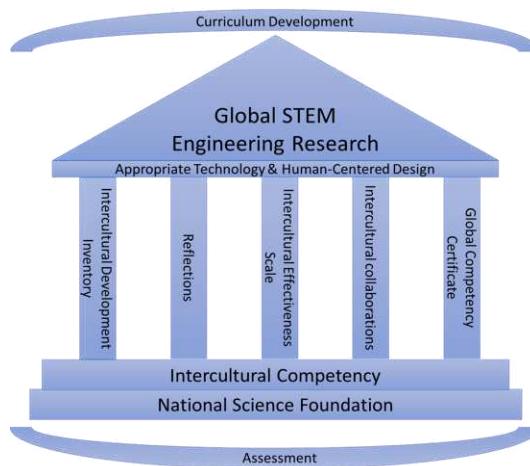


Figure 3. Global STEM RET Foundational Principles

## **Impact of COVID-19**

The Global STEM RET was paused for nearly two years due to social distancing guidelines and restrictions on travel. When the program resumed in January 2022, all 12 original participants indicated they were interested in continuing the program and preparation began for Summer 2022 immersions. However as preparations continued, only 6 of the original participants were able to commit to full program participation.

Most participants indicated that the two-year break during COVID was stressful and chaotic, with very little opportunity to think about or incorporate ethical engineering or human centered design into lesson planning. To prepare for the immersion, the participants engaged with the Global STEM Research team in re-orientation sessions beginning January 2022. The original evaluation plan included PhotoVoice for participants to share the immersion experience. However, while the participants were in-country for the immersion and after returning, online fatigue was evident in the participant's reflective responses, which were short and contained little detail. In order to investigate a deeper understanding of the program impacts, the deliverable requirement for completion moved to more traditional PowerPoint and poster submissions. The evaluator conducted interviews in lieu of surveys, which were not a part of the original evaluation, but yielded deeper, more thoughtful verbal responses.

Recent increases in fuel and airline travel as well as increasing prices for goods and services raised concerns over the scope of the project as there may be a need to reduce the number of participants or secure additional funding to adequately cover travel expenses. For the 2022-2023 cohort, approximately 60% of the participant travel budget was used in support of 50% of the original participants.

## **Ongoing and Future Work**

Currently, the 2023-2024 Global STEM program has 11 participants slated for international summer immersions. The cohort is preparing for their summer immersions through a series of orientation sessions with a focus on intercultural development while learning about Ethos community partners and the technologies they will encounter on the immersion.

For the 2023-2024 cohort, the team has added the Global Competency Certificate (GCC) to the Global STEM orientation sessions to help better prepare teachers for their international immersions. The GCC is a blended learning program that helps users develop tangible global skills including self awareness, awareness of others, and emotional intelligence. Research shows that individuals who participate in group mentoring through the GCC prior to and during their immersion experiences have not only an improved intercultural competence but also greater cultural humility when compared to individuals that did not receive this support prior to their immersion experience [19].

## **Acknowledgements**

This material is based upon work supported by the National Science Foundation under Grant Numbers 1855231 and 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

1. Habashi, M., Grauabim W., Evangelou, D & Ngambecki, L. (2008, July). Age related gender differences in engineering. Presented at the Research in Engineering Education Symposium. Davos, Switzerland.
2. Tokar, D. Thompson, M., Plaufcan, M., & Williams, C. (2007). Precursors of learning experiences in social cognitive career theory. *Journal of Vocational Behavior*, 71, 319-339. Doi: 10.1016/j.jvb.2007.08.002.
3. Tokar, D. Thompson, M., Plaufcan, M., & Williams, C. (2007). Precursors of learning experiences in social cognitive career theory. *Journal of Vocational Behavior*, 71, 319-339. Doi: 10.1016/j.jvb.2007.08.002.
4. Duncan, D., Diefes-Dux, H., & Gentry, M. (2011) Professional development through engineering academies: An examination of elementary teachers' recognition and understanding of engineering. *Journal of Engineering Education*. 100, 520-539.
5. Creswell, J., & Plano-Clark, V. (2007). *Designing and conducting mixed methods research*. 2nd ed. New York: Sage.
6. Guba, E. G., & Lincoln, Y. S. (1994). Competing paradigms in qualitative research. *Handbook of qualitative research*, 2, 163-194.
7. Shenton, A. K. (2004). Strategies for ensuring trustworthiness in qualitative research projects. *Education for Information*, 22(2), 63-75.
8. Boix-Mansilla, V., & Jackson, T. (2011). Educating for global competence: Preparing our youth to engage the world. Council of Chief Schools Officers [http://www.ccsso.org/Resources/Publications/Educating\\_for\\_Global\\_Competence.html](http://www.ccsso.org/Resources/Publications/Educating_for_Global_Competence.html).
9. Longview Foundations. (2008). Teacher preparation for a global age. Washington, DC: Longview.
10. Martin, J. N., & Nakayama, T. K. (2013). *Intercultural communication in contexts* (6th ed.). New York: McGraw Hill.
11. Dejaeghere, J. & Zhang, Y. (2008). Development of intercultural competence among US American teachers: Professional development factors that enhance competence. *Intercultural Education*. 19. Pp. 255-268. 10.1080/14675980802078624.
12. Walters, L., Garii, B., & Walters, T. (2009). Learning Globally, Teaching Locally: Incorporating International Exchange and Intercultural Learning into Pre-Service Teacher Training. *Intercultural Education* 20:1 pp S151-S158. doi.org/10.1080/14675980903371050.
13. Germuth, A.A., Banilower, E.R. and Shimkus E.S. (2003). Test-Retest Reliability of the Local Systemic Change Teacher Questionnaire. Prepared for National Science Foundation. Available at: [http://w.horizon-research.com/LSC/news/tq\\_test\\_retest.pdf](http://w.horizon-research.com/LSC/news/tq_test_retest.pdf), accessed September 8, 2018.
14. Savin-Baden, M., & Major, C. H. (2013). *Qualitative research*. London: Routledge.
15. Bennett, M. (1993). Towards ethnorelativism: A developmental model of intercultural sensitivity. In M. Paige (Ed.), *Cross-cultural orientation* (pp. 27-69). Lanham, MD: University Press of America.

16. Hammer, M. R. (1999). A measure of intercultural sensitivity: The intercultural development inventory. In S. M. Fowler & M. G. Mumford (Eds.), *Intercultural sourcebook: Cross-cultural training methods* (Vol. 2, pp. 61-72). Yaumouth, ME: Intercultural Press.
17. Hammer, M. R. (2007). *Intercultural Development Inventory Manual* (v 3). Ocean Pines, MD: IDI, LLC.
18. Hammer, M. R. (2003). Measuring intercultural sensitivity: The Intercultural Development Inventory. *International journal of intercultural relations*, 27, 403–419.
19. Hammer, M. R. (2009a). IDI individual report for education, version 3. Ocean Pines, MD: IDI, LLC.
20. Hammer, M. R. (2009b). The intercultural development inventory (IDI): An approach for assessing and building intercultural competence. In M. A. Moodian (Ed.), *Contemporary leadership and intercultural competence: Exploring the cross-cultural dynamics within organizations* (pp. 203-218). Thousand Oaks, CA: Sage.
21. Hammer, M. R. (2012). The intercultural development inventory. In M. V. Vande Berg, R. M. Paige, & K. H. Lou (Eds.), *Student learning abroad: What our students are learning, what they're not, and what we can do about it* (pp. 115e136). Sterling, VA: Stylus Publishing.
22. 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), 467-486.
23. Jones, D.C., Campbell, M., Acheson-Clair, K., & Yngve, K. (2019). *Summary of Intercultural Learning in Semester Abroad Programs: A Comparative Analysis of Mentoring Programs*.
24. Mendenhall, M.E., Stevens, M.J., Bird, A, Oddou, G.R., & Osland, J., (2012). Specification of the content domain of the Intercultural Effectiveness Scale. *The Kozai Monograph Series*, 1(3). Chesterfield, MO: Kozai Group.