

# UC Riverside

## UC Riverside Previously Published Works

### Title

Building Compassion and Human Bridges through Research Collaborations

### Permalink

<https://escholarship.org/uc/item/7wf952gh>

### Journal

ACS Omega, 7(2)

### ISSN

2470-1343

### Authors

Graeve, Olivia A  
de la Cadena, Jorge A Arróyave García  
López, Aranza S Martínez

### Publication Date

2022-01-18

### DOI

10.1021/acsomega.1c04916

Peer reviewed

# Building Compassion and Human Bridges through Research Collaborations

Olivia A. Graeve,\* Jorge A. Arróyave García de la Cadena, and Aranza S. Martínez López

Cite This: *ACS Omega* 2022, 7, 1542–1546

Read Online

ACCESS |

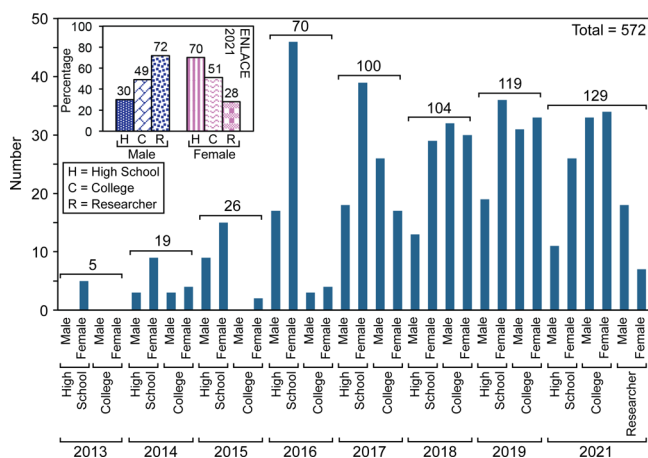
Metrics & More

Article Recommendations

**ABSTRACT:** Our ENLACE binational summer research program was established with the aim of encouraging the participation of high school and college students in research in the sciences and engineering, while promoting cross-border friendships between the United States and Mexico. The program unites students around science and engineering questions and concurrently engages them in a rich curriculum that promotes understanding of broader societal issues of equity, inclusion, tolerance, and social justice. Because we built our program around hope and cooperation, it is our aspiration and promise that walls and borders—all kinds of walls and borders—can be eradicated through kindness, compassion, and respect for others. ENLACE is not just a program we organize every summer, it is also a program that defines who we are as people and the kind of contribution we want to make in the world.

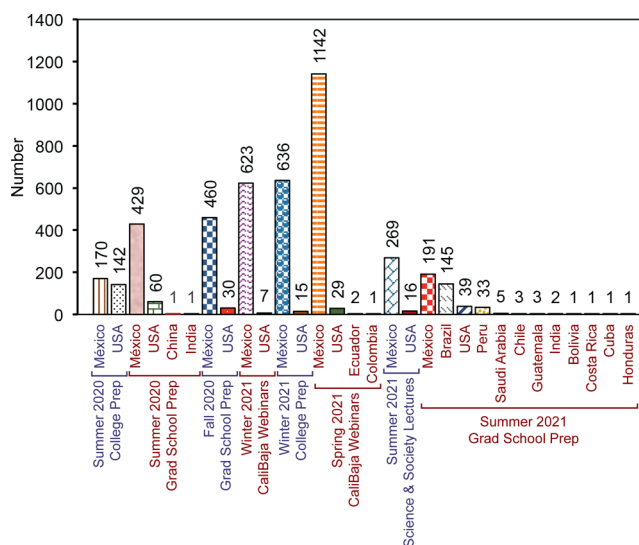


We have often been asked why it is important to promote and implement gender and ethnic diversity in academia



**Figure 1.** ENLACE participants from 2013 to 2021. Numbers above the histograms in the main chart represent the total participants per year. The inset represents the percent of males and females of each category (H = high school, C = college, and R = researcher) for the 2021 cohort.

and industry. One common justification originates from the social science literature, which describes that diversity has a positive impact on innovation, transparency, and financial performance.<sup>1–6</sup> However, we do not believe that diversity should only be justified based on economic considerations. Diversity has many more positive outcomes. It promotes human understanding and compassion and allows people of all identities to recognize value in others and themselves. We are



**Figure 2.** Participant numbers (excluding the ENLACE participants) during 2020–2021 for the foundational activities of the ENLACE program, which include the Grad School Prep program, College Prep program, Science & Society Lectures, and CaliBaja Webinars. These efforts support students during the summer and the academic year as part of the year-long engagement efforts with ENLACE students as well as other students principally from the United States and Mexico. Our intent is to continue growing these programs into Latin America to serve over 2000 students per year.

Received: September 7, 2021

Accepted: December 24, 2021

Published: January 6, 2022



**Figure 3.** ENLACE 2018 cohort with Musician Nathan East during one of the Science & Society Lectures. Photographs courtesy of Erik Jepsen. Copyright 2021.

convinced it is the solution to world peace, and with a fervent belief in the beauty of peace, we have built an educational program where diversity takes center stage. The ENLACE summer research program was built on hope, a hope that we can build something extraordinary, with kindness, compassion, and respect for others. Hope that we can eliminate borders and bring down walls.

The Tijuana-San Diego border region—our home—is our inspiration. It has allowed us to connect with extraordinary people who are up to the challenge of exploring and solving the extreme social and economic challenges found along the Tijuana-San Diego border, the busiest border in the world, a place where extremes collide and converge to form a unique social fabric and an emerging binational identity. Our own contribution has taken the form of the ENLACE summer research program, which we initiated in 2013 by inviting five high school girls from Tijuana to experience a summer of research at UC San Diego. The program was established with the aim of encouraging the participation of high school and college students in research in science and engineering, while promoting cross-border friendships between the United States and Mexico. Participants are organized in pairs (one from each side of the border), and they work together in research laboratories from across the UC San Diego campus. The program is unique in its large-scale implementation of cross-border collaboration and offers opportunities in engineering, physical sciences, biological sciences, and health sciences.

ENLACE participants experience daily life at a major research university while building cross-border friendships with peers based on the conviction that friendships built at a young age are the most honest friendships one will ever have. Our goal is to teach students how to connect with each other through the lens of science and entice them to consider graduate degrees with the hope that in the future they may influence the way science is practiced across borders. We envision a future in which a former ENLACE participant becomes the President of the United States and another becomes the President of Mexico and they have been friends

since they were 17 years old. This is so powerful! It can bring down all kinds of walls.

The program is now in its 8th year and there are 572 alumni. As mentioned earlier, the first cohort of students consisted of five high school girls from Tijuana. In subsequent years, the numbers increased to 19 (2014), 26 (2015), 70 (2016), 100 (2017), 104 (2018), 119 (2019), and 129 (2021), quickly transitioning into an established and large-scale summer research program that has been extremely effective in promoting Science, Technology, Engineering, and Mathematics (STEM) careers and the formation of the future workforce among students from the United States and Mexico, even resulting in journal coauthorship for some of the participants.<sup>7–15</sup> Figure 1 illustrates the distribution of participants by year and level (i.e., high school or college). The program heavily focused on high school students during the first 4 years, subsequently transitioning to a program that served both high school and college students. We initiated with a focus on high school students because of the anticipation that logistics would be more difficult for that population and was best to resolve it at the outset. Indeed, opening research opportunities to minors from a foreign country was not easy, but it was manageable and not as complicated as initially considered. Finally, this year (Summer 2021), the program was also opened to academic researchers from Mexico who are interested in establishing collaborations with colleagues at UC San Diego; thus, the program now comes full circle in serving high school students, college students, and researchers/teachers, promoting engagement of the 21st century scientists and engineers who are bicultural, bilingual, globally engaged, and culturally competent and can connect and communicate across borders, a true “science without borders” effort.<sup>16–18</sup>

With the intention and goals of promoting human bridges, building community, and growing attitudes of compassion, a variety of ancillary activities have been established for the ENLACE participants and others who are able to join virtually (see Figure 2 for numbers of other participants during the 2020–2021 academic year). We are enthusiastic to see that participation is increasing both with respect to numbers and



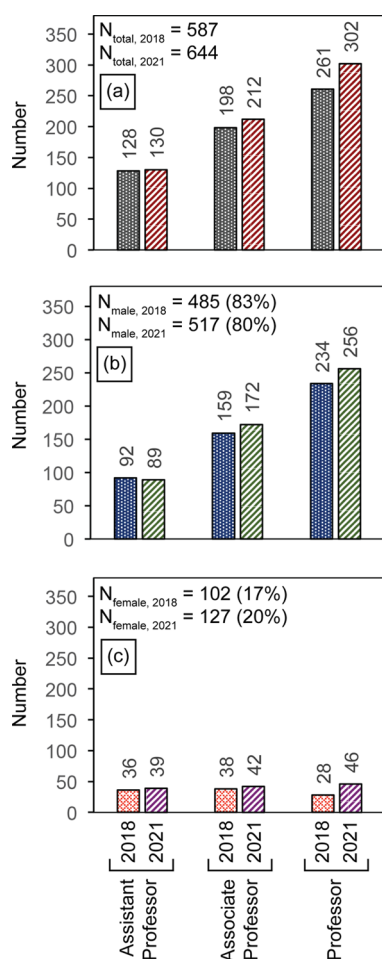
**Figure 4.** Messages from former ENLACE participants.

nationalities. Our efforts include (A) The Science and Society Lectures: With the purpose of exposing participants to role models as well as challenge their aspirations, participants connect once a week during the 7 weeks of ENLACE to learn from a variety of guest speakers. We have been fortunate to enjoy the participation of outstanding speakers, including Mara Elliott, San Diego City Attorney,<sup>15</sup> Ambassador Carlos González Gutiérrez, Consul General of Mexico in San Diego,<sup>20</sup> Gonzalo P. Curiel, Judge,<sup>21</sup> Fanny Krasner Lebovits, Author and Speaker, Holocaust Survivor,<sup>22</sup> and Nathan East, Musician<sup>23</sup> (see Figure 3). (B) The Futures Summit: With the message of "Si Se Puede" and the goal of establishing worthy life goals, this is an annual one-day event for former and current ENLACE participants. For former ENLACE participants, it is a follow-up of the goals they developed during their participation in the program. For the current ENLACE participants, it is an opportunity to introduce them to the

ENLACE community of alumni and to begin the process of establishing their own life goals. (C) Anti-Bias Training: With the goal of promoting empathy and compassion, it is organized in collaboration with ADL<sup>24</sup> as an annual one- or two-day event for former and current ENLACE participants. (D) College Prep and Graduate School Prep: With the purpose of educating students on the process of applying to college (for high school students) and graduate school (for undergraduate students), this training takes place during the academic year and summer for former and current ENLACE students as well as students from other academic institutions from across the United States and Latin America.

In terms of outcomes, the program has been both galvanizing and transformational for the students. It has had a self-reported impact on college choice, choice of major, expectations of college life, and knowledge of college admission processes. In addition, participants have repeatedly





**Figure 5.** (a) Total number of Latino engineering tenure track and tenured faculty in the 50 U.S. states by rank and the corresponding numbers of (b) men and (c) women for 2018 and 2021.

expressed genuine gratitude for the opportunity to participate. The sense of autonomy is very significant for these students. Living “on their own” is something they take great pride in, giving them the opportunity to connect and share living experiences with their dormitory mates. Together, they work through everyday challenges, learning how to collaborate cross-culturally and as a team. Even though many of the students arrive to the program with college or graduate school plans, participants have described that participation in ENLACE has “significantly modified” their college goals and energized their aspirations. These modifications come not only in part from their laboratory experiences (influencing the type of science or engineering they hope to pursue) but also from other sources such as participation in complimentary campus events and largely from the informal interactions with their graduate and undergraduate colleagues with whom they spend the largest amount of time. This suggests that simply experiencing campus life is a major asset to the program. A typical response from student participants is “I left the program a better version of myself.” A beautiful sentiment! We present in Figure 4 some stunning personal statements of former ENLACE participants.

One student describes how she “loved that most of the speakers were Latino, as it showed [her] the tremendous impact we have in the political, scientific, and engineering communities.” Representation matters, and during the program, we strive to include minority role models and

speakers. While diversity in academia among the faculty ranks remains an elusive goal for many higher education institutions,<sup>25</sup> we have managed highly effective connections to role models through forged efforts in collaboration with the Society of Hispanic Professional Engineers (SHPE).<sup>26</sup> Because of our activities with SHPE, we collected and reported statistics of Latino engineering faculty at U.S. institutions in 2018,<sup>27</sup> obtained from all universities that have a College of Engineering listed in the U.S. News & World Report National College Rankings.<sup>28</sup> Here, we update those statistics to show that the numbers of Latino engineering faculty are improving but only minimally. While the statistics are only focused on engineering, we suspect the trends are similar for other STEM disciplines.

In 2018, there were 587 Latino engineering faculty in the United States, representing only 3.6% of the total engineering faculty across the United States, of whom 485 (83%) were male and 102 (17%) were female. In 2021, an increase to 644 is observed, with 517 (80%) males and 127 (20%) females (Figure 5). Women continue to be significantly underrepresented at all levels of the academic ladder, but in total, the percentage has increased from 17 to 20%, a positive trend that one hopes may continue. The inset in Figure 1 represents the gender of ENLACE 2021 participants at the high school (H), college (C), and researcher (R) levels. At the high school level, ENLACE 2021 consisted of 30% males and 70% females. The percentages by gender of college participants were 49% males and 51% females, and the percentages of researchers were 72% males and 28% females. Thus, we have a significant majority of young women at the high school level interested in STEM fields, with the percentages decreasing as students progress to college and academic positions. We clarify that selection of ENLACE participants is not based on gender but on grades, letters of recommendation, a statement of purpose, and geographic distribution across the United States and Mexico. Thus, the participants represent approximate ratios of gender distribution among the applicants to the program. While the ENLACE 2021 numbers are far from representing general statistics for the entire U.S. or Mexican populations, they are indicative of trends we have seen year after year. As students climb into higher education, women decrease in numbers in the STEM fields;<sup>29–34</sup> thus, the percentages of Latino engineering faculty are not surprising, especially the low numbers of women faculty. It is our hope that the significant numbers of girls at the high school level participating in ENLACE will eventually make an impact at the highest academic levels to achieve gender parity. Also, as we continue growing our programs through the UC San Diego CaliBaja Center for Resilient Materials and Systems,<sup>35</sup> it is our aspiration and promise that walls and borders—all kinds of walls and borders—can be eradicated through kindness, compassion, and respect for others. ENLACE is not just a program we organize every summer, it is also a program that defines who we are as people and the kind of contribution we want to make in the world.

## ■ AUTHOR INFORMATION

### Corresponding Author

Olivia A. Graeve – Department of Mechanical and Aerospace Engineering, University of California San Diego, La Jolla, California 92093-0411, United States; [orcid.org/0000-0003-3599-0502](https://orcid.org/0000-0003-3599-0502); Email: [ograeve@ucsd.edu](mailto:ograeve@ucsd.edu)

## Authors

Jorge A. Arróyave García de la Cadena – Department of Mechanical and Aerospace Engineering, University of California San Diego, La Jolla, California 92093-0411, United States

Aranza S. Martínez López – Department of Mechanical and Aerospace Engineering, University of California San Diego, La Jolla, California 92093-0411, United States

Complete contact information is available at:

<https://pubs.acs.org/10.1021/acsomega.1c04916>

## Notes

The authors declare no competing financial interest.

## ACKNOWLEDGMENTS

Partial support for this project was secured through a grant from the National Science Foundation (grant #1911372).

## REFERENCES

- (1) Upadhyay, A.; Zeng, H. Gender and ethnic diversity on boards and corporate information environment. *J. Bus. Res.* **2014**, *67*, 2456–2463.
- (2) Singh, V. Ethnic diversity on top corporate boards: a resource dependency perspective. *Int. J. Hum. Resour. Manag.* **2007**, *18*, 2128–2146.
- (3) Carter, D. A.; D'Souza, F.; Simkins, B. J.; Simpson, W. G. The gender and ethnic diversity of US boards and board committees and firm financial performance. *Corp. Gov.* **2010**, *18*, 396–414.
- (4) Levine, S. S.; Apfelbaum, E. P.; Bernard, M.; Bartelt, V. L.; Zajac, E. J.; Stark, D. Ethnic diversity deflates price bubbles. *Proc. Natl. Acad. Sci. U. S. A.* **2014**, *111*, 18524–18529.
- (5) Gutiérrez-Fernández, M.; Fernández-Torres, Y. Does gender diversity influence business efficiency? An analysis from the social perspective of CSR. *Sustainability* **2020**, *12*, 3865.
- (6) Parrotta, P.; Pozzoli, D.; Pytlikova, M. The nexus between labor diversity and firm's innovation. *J. Popul. Econ.* **2014**, *27*, 303–364.
- (7) Schiffer, J. M.; Feher, V. A.; Malmstrom, R. D.; Sida, R.; Amaro, R. E. Capturing invisible motions in the transition from ground to rare excited states of T4 lysozyme L99A. *Biophys. J.* **2016**, *111*, P1631–P1640.
- (8) Su, F. Y.; Pang, S.; Ling, Y. T. T.; Shyu, P.; Novitskaya, E.; Seo, K.; Lambert, S.; Zarate, K.; Graeve, O. A.; Jasiuk, I.; McKittrick, J. Deproteinization of cortical bone: Effects of different treatments. *Calcif. Tissue Int.* **2018**, *103*, 554–566.
- (9) Fannon, M. J.; Mysore, K. K.; Williams, J.; Quach, L. W.; Purohit, D. C.; Sibley, B. D.; Sage-Sepulveda, J. S.; Kharidia, K. M.; Morales Silva, R. J.; Terranova, M. J.; Somkuwar, S. S.; Staples, M. S.; Mandyam, C. D. Hippocampal neural progenitor cells play a distinct role in fear memory retrieval in male and female CIE rats. *Neuropharmacology* **2018**, *143*, 239–249.
- (10) Jolival, C. G.; Marquez, A.; Quach, D.; Navarro-Diaz, M. C.; Anaya, C.; Kifle, B.; Muttalib, N.; Sanchez, G.; Guernsey, L.; Hefferan, M.; Smith, D. R.; Fernyhough, P.; Johe, K.; Calcutt, N. A. Amelioration of both central and peripheral neuropathy in mouse models of type 1 and type 2 diabetes by the neurogenic molecule NSI-189. *Diabetes* **2019**, *68*, 2143–2154.
- (11) Raquel Rocha, L.; Nguyen Huu, V. A.; Palomino La Torre, C.; Xu, Q.; Jabari, M.; Krawczyk, M.; Weinreb, R. N.; Skowronska-Krawczyk, D. Early removal of senescent cells protects retinal ganglion cells loss in experimental ocular hypertension. *Aging Cell* **2020**, *19*, No. e13089.
- (12) Li, Y.; Maldonado-Lopez, D.; Rios Vargas, V.; Zhang, J.; Yang, K. Stability diagrams, defect tolerance, and absorption coefficients of hybrid halide semiconductors: High-throughput first-principles characterization. *J. Chem. Phys.* **2020**, *152*, No. 084106.
- (13) Aylward, A.; Okino, M.-L.; Benaglio, P.; Chiou, J.; Beebe, E.; Padilla, J. A.; Diep, S.; Gaulton, K. J. Glucocorticoid signaling in pancreatic islets modulates gene regulatory programs and genetic risk of type 2 diabetes. *PLoS Genet.* **2021**, *17*, No. e1009531.
- (14) Wirth, D. M.; Jaquez, A.; Gandarilla, S.; Hochberg, J. D.; Church, D. C.; Pokorski, J. K. Highly expandable foam for lithographic 3D printing. *ACS Appl. Mater. Interfaces* **2020**, *12*, 19033–19043.
- (15) Ren, T.; Tran, R.; Lee, S.; Bandera, A.; Herrera, M.; Li, X.-G.; Ong, S. P.; Graeve, O. A. Morphology control of tantalum carbide nanoparticles through dopant additions. *J. Phys. Chem. C* **2021**, *125*, 10665–10675.
- (16) <http://www.sandiegouniontribune.com/news/border-baja-california/sd-ucsd-science-program-seeks-to-bridge-border-2016aug04-story.html>
- (17) <https://www.cbs8.com/article/news/local/outreach/innovate8/enlace-stem-program-bridges-two-countries/509-5f1a5445-39f7-43e3-a163-c6ea850eb5cf>
- (18) <https://www.kpbs.org/news/2018/aug/02/uc-san-diego-science-program-unites-students-both/>
- (19) [https://en.wikipedia.org/wiki/Mara\\_Elliott](https://en.wikipedia.org/wiki/Mara_Elliott)
- (20) [https://en.wikipedia.org/wiki/Carlos\\_Gonzalez\\_Gutierrez](https://en.wikipedia.org/wiki/Carlos_Gonzalez_Gutierrez)
- (21) [https://en.wikipedia.org/wiki/Gonzalo\\_P.\\_Curriel](https://en.wikipedia.org/wiki/Gonzalo_P._Curriel)
- (22) <https://www.facebook.com/FannyLebovits/>
- (23) <http://nathaneast.com/>
- (24) <https://www.adl.org/what-we-do/promote-respect/anti-bias>
- (25) Contreras, F. Latino faculty in hispanic-serving institutions: where is the diversity? *AMAE J.* **2017**, *11*, 223–250.
- (26) <https://www.shpe.org/>
- (27) Arellano, G. N.; Jaime-Acuña, O.; Graeve, O. A. Latino engineering faculty in the United States. *MRS Bull.* **2018**, *43*, 131–147.
- (28) <https://www.usnews.com/best-colleges/rankings/national-universities>
- (29) Wickware, P. Along the leaky pipeline. *Nature* **1997**, *390*, 202–203.
- (30) Atkin, A. M.; Green, R.; McLaughlin, L. Patching the leaky pipeline: keeping first-year college women interested in science. *JCST* **2002**, *32*, 102–108.
- (31) Blickenstaff, J. C. Women and science careers: leaky pipeline or gender filter? *Gen. Educ.* **2006**, *17*, 369–386.
- (32) Pell, A. N. Fixing the leaky pipeline: women scientists in academia. *J. Anim. Sci.* **1996**, *74*, 2843–2848.
- (33) Chesler, N. C.; Barabino, G.; Bhatia, S. N.; Richards-Kortum, R. The pipeline still leaks and more than you think: A status report on gender diversity in biomedical engineering. *Ann. Biomed. Eng.* **2010**, *38*, 1928–1935.
- (34) Liu, S.-N. C.; Brown, S. E. V.; Sabat, I. E. Patching the “leaky pipeline”: interventions for women of color faculty in STEM academia. *Arch. Sci. Psychol.* **2019**, *7*, 32–39.
- (35) <http://resilientmaterials.ucsd.edu/>