

## Strategies to Foster LatinX Inclusion in Microbiology Programs

Lilliam Casillas Martinez

*Biology Department, University of Puerto Rico—Humacao, Humacao, PR 00791*

**Inclusion is an active, powerful, and emotional noun that over the past years has helped me reconcile my main passions in life: microbiology, teaching, research, and mentoring. Although I am now part of an inclusive excellence family, during my graduate school I always felt alone, like an imposter microbiologist. I want to avoid other Latinas feeling the same way; consequently, I share frameworks and strategies here to foster inclusion in Microbiology departments. I have been teaching Microbiology for more than 20 years at a Hispanic-Serving Institution (HSI), and my strategies range from the personal to the institutional level. As a first-generation Latina who barely survived in a Microbiology graduate program at a Primarily White Institution (PWI), I emphasize how culture can affect student learning. I use the example of microbial mats, resilient laminated ecosystems, as inclusive communities in the microbial world.**

### INTRODUCTION

Microbial mats are the best example of an inclusive community in the microbial world. These different groups of metabolically diverse organisms (i.e., cyanobacteria, anoxyphototrophs, heterotrophic bacteria, and anaerobes) all learn to cope and collaborate with each other for the survival of the mat. I have learned many lessons from these majestic and highly productive laminated ecosystems while using them for teaching and conducting research in my microbiology courses (1). Indeed, my most valuable lessons stem from their resilience and the way these microbial groups survive even under the most extreme circumstances. Today I want to use them while writing this reflection on inclusion in microbiology as Director of the Puerto Rico Outstanding Undergraduate Diversified (PROUD) program funded by the Inclusive Excellence Program of the Howard Hughes Medical Institutes (HHMI). As a first-generation Latina who survived in a microbiology graduate program at a Primarily White Institution (PWI) and has been teaching microbiology for more than twenty years at a Hispanic-Serving Institution (HSI), I would like to provide some strategies to foster the inclusion of more LatinX people. My strategies range from the personal, as a STEM faculty member, to the departmental, and finally to the institutional level.

### Inclusive excellence starts after a personal introspection

For many years, the diversity and inclusion initiatives at universities were left to institutional diversity offices. However, most literature agrees that those efforts have failed (2). Inclusive excellence is a new movement that promotes inclusion that begins at a personal level, starting in the classroom and then moving to departmental and institutional levels (3). In my case, I realized that, as STEM faculty, I lacked many educational and pedagogical skills since most of my training was in microbiology—conducting physiology, metabolism, or genetic research. Consequently, when I was hired as a professor at a Hispanic-Serving Institution (HSI), I had no idea of the educational training I needed in order to become a successful academic and mentor. I started reading about educational models like the Hurtado's, which is based on 30 years of research on underrepresented populations in higher education, specially at HSIs (4). This model for diverse learning environments (DLE) not only works with the campus climate and historical legacy but also the compositional diversity of students, faculty, and staff. Interestingly, the DLE model also emphasizes the individual-level life experiences of students and faculty. As a microbiology professor, I was not aware that culture plays a key role in the success of LatinX students until I started reading studies regarding college persistence and came across Castellanos and Gloria's psychosociocultural (PSC) theoretical framework (5). According to the PSC framework, college persistence among LatinX students is based on three dimensions: psychological, social, and cultural (5). I was never taught that culture has any relationship with the learning process of my

---

Corresponding author. Mailing address: Biology Department, Box 860, University of Puerto Rico, Humacao, PR 00792. Phone: 787-850-9300. Fax: 787-850-9354. E-mail: [lilliam.casillas@upr.edu](mailto:lilliam.casillas@upr.edu).

Received: 6 January 2020, Accepted: 6 February 2020, Published: 10 April 2020

students. Ethnic identity, cultural congruity, and acculturation were new terms I learned that play an important part in the success of my students (6, 7). Furthermore, Yosso's Cultural Wealth Model represents how students of color access and experience college based on six forms of cultural capital that include aspirational, linguistic, familial, social, navigational, and resistance (8). All these forms of capital can be used to empower LatinX people in the classroom, and I have combined them with my research in microbiology to help more than 200 undergraduates over the last 20 years. More than 20 of these students currently hold PhDs and are agents of change in other universities. However, during my microbiology graduate training at a PWI, I lacked this form of (much needed) empowering. After deep introspection I now believe it was my familial, social, and resistance capital which allowed me to survive. My familial capital was a positive and a negative force. Thinking about my family and my community back home in Puerto Rico helped me to keep going but, at the same time, imposed an extra weight I did not expect to carry. As a first-generation Latina college student in my family, I had to make it. My family and community expected me to. I only encountered a few faculty members in my microbiology department who understood such pressure—most were completely unaware. If I had encountered a more inclusive environment, where cultural pressures could be discussed, I would have been more productive. Understanding how cultural elements affect student learning is a must for a diverse institution.

### Understanding how cultural elements affect student learning

There are several cultural constructs that are important for LatinX people to succeed at any university. For example, ethnic identity is the extent to which one identifies with a particular ethnic group. In the case of the LatinX group, ethnic identity tends to be really strong. We are very family-focused and gregarious, not independent, as universities are. Ethnic identity may be challenged while attending university by the discrimination and prejudice we face every day in non-inclusive classrooms. LatinX people are often stereotyped with regard to their values on education and linguistic barriers, often being characterized as low-achieving (9). I was very surprised as a graduate student when I learned there was a whole new vocabulary that was used to label my group. Terms like underrepresented, underprepared, underachieved, minority, and non-proficient in English. These were never part of my vocabulary before my graduate experience. Negative terms like this made me feel I had to constantly work harder than everyone else to prove that I belonged. However, LatinX identity can be used to empower self-efficacy. A positive relationship between ethnic identity and personal wellbeing has been reported when students are empowered with their unique abilities as Latinos and this increases their self-esteem and optimism (9). A strong ethnic identity serves as a protective factor

to counteract negative cultural stereotypes (10, 11). In my experience, students who identify with successful faculty from their own ethnic groups benefit in terms of academic self-efficacy. For example, there is evidence that Latinas represent a role model for other Latinas in academia (11). Consequently, hiring faculty from the same ethnic group or cultural background as the students is necessary in any microbiology department in order for those students to feel represented and increase their chances of succeeding in science (11). In my opinion, the least any microbiology department should do to become inclusive is to diversify its lecture series. Every semester, the department should invite faculty from different backgrounds to give seminars. In the microbiology department where I completed my doctoral degree (over a six-year period), I never saw a LatinX person giving a seminar. I unconsciously got the message that members of my ethnic group were not part of the higher education system. That created an impostor syndrome complex where I always felt like an intruder in my research laboratory or my classrooms. I never developed a sense of belonging. If, for example, I got awards for my scientific excellence, I used to think, "I got this award because I was the only Latina nominated," and I never considered it possible that I got the prize because of my hard work. Such a sense of insecurity about my ability to perform exceptionally in microbiology is still hiding within me. If, at the time, I had had mentors from my ethnic group, I would probably not have developed such a fragility and insecurity and would have been much more productive as a student.

Cultural congruity is another important construct of the PSC framework. It refers to the imbalance resulting from my cultural values as a student and the expectations of my academic environment (12, 13). The university culture was not compatible with some of my LatinX values learned at home. For example, as a Latina, I was interdependent on my families (a phenomenon named familiarism), but when in the university setting, I was required to be self-reliant. According to my culture, I had to always collaborate, and rarely compete. Once I was in the lab, most of the dynamics were based on competition, which was a bit contradictory to me. It is important to understand that when a LatinX student comes to a classroom or a laboratory, such settings become their extended family. Therefore, comments such as "leave your culture outside of the lab" will really confuse them. Indeed, many LatinX students experience internal conflict when their cultural and spiritual values are not congruent with their daily routine in the academic environment. But instead of talking about such conflicts with a mental health professional, we tend to resist and try to keep going. Sampe (14) recently conducted a study that showed Latin Americans are resistant to finding counseling services and proposed that universities establish seminars for them on how to manage cultural and familial stress and to promote cultural connection and ethnic pride.

Finally, acculturative stress has been defined as a set of emotional distresses and internal conflicts experienced when demands of the host culture clash with the values of the native culture (15). This stress is particularly evident when a Latina student decides to follow a research-oriented career instead of a career that allows her to be a caretaker in her community, such as medicine or nursing. Furthermore, if the research conducted involves collaborations with STEM fields seen as highly masculine, such as mathematics and physics, the conflict is even greater. Efforts to adapt to these male-dominated environments will clash with family values, as Latinas in general are expected to be feminine and follow a so-called nurturing nature. In our university, we have addressed this incongruence by conducting a series of interventions, such as a Women and Science course, where the struggles of other Latinas were discussed and survival strategies highlighted. Ten percent of our faculty are first-generation and proud of their heritage. This has been key for their persistence in STEM and gives them a strong understanding of the challenges many of our students face. In summary, cultural differences do play an important role in the academic success of LatinX students, and it is important to develop specific culturally sensitive strategies, such as hiring LatinX faculty as mentors and being willing to discuss cultural incongruences, in order to foster the academic achievement of future microbiologists.

### **Strategies to foster a culturally responsive environment in my microbiology course**

Active learning is known to be one of the best equalizers in STEM education. While engaging in a research project in the classroom, students have no barriers—they are all the same. The Tiny Earth curriculum (16), designed by Jo Handelsman at the University of Wisconsin, Madison, has been a real game changer in my microbiology classroom since it was implemented in 2014. While teaching the General Microbiology Laboratory every semester, I have 20 students who conduct research and are part of a universal force against microbial resistance. Tiny Earth is a discovery-based exercise where students bring samples of soil from their back yards, closets, or extreme environments of the island and search for novel antibiotics from them. I use the Tiny Earth as a multicultural experience that affirms our culture while validating a research experience. For example, sometimes we sample endemic frogs that are also cultural symbols of Puerto Rico. Students are empowered to look for “Puerto Rican bacteria” (as they like to call them) and try to discover and engage in the local economy by discovering new “Puerto Rican antibiotics.” By conducting these different research projects, students learn to think critically and formulate experiments using a backward design (17). Unfortunately, in mainstream textbooks, the voices of underrepresented students are largely excluded from the STEM curricula. These types of activities, which engage in location-specific

and culturally relevant research, change the narrative and allow them to become active players.

At the end of the Tiny Earth experience, students can present their findings to other colleges; they are also invited to participate in a yearly conference either at the American Society for Microbiologists (ASM) general meeting or at the Tiny Earth Yearly Symposium at the University of Madison, Wisconsin. Participation in these meetings allows students to bring their culture and ethnicity and share with students from other PWI without fear of rejection. It is imperative that initiatives like Tiny Earth promote these interactions and foster more collaborations among students from HSIs and PWI. Tiny Earth has been a very effective discovery-based curriculum for us, especially as it can be easily included in the syllabus of any General Microbiology Laboratory with a minimum of time required by the professor. Another initiative that can be similarly adapted to a General Biology Course is the SEA-Phages Program from the Howard Hughes Medical Institute (18). In this program, faculty and students analyze the diversity of the bacteriophage populations in soils while engaged in the discovery of new viruses, genome annotation, and comparative genomics. Students gain a strong self-identification with research and are motivated to continue future research in genomics (18). Both initiatives can be implemented at PWI and used to foster collaborations with HSIs. At the end of each semester, students from these universities can share their findings, compare results, and offer suggestions for new experimental designs to be followed in the future.

### **Fostering inclusion through faculty development**

Faculty development programs play an important role in how inclusive an institution is. As previously stated, STEM faculty need to be trained on difficult subjects, such as inclusion, equity in the classroom, racism, implicit bias, and stereotype threat. However, not all institutions have the funds or the infrastructure to conduct this training. Fortunately, some of the initiatives are either free or accessible at very low cost. For example, the Ambassador Program from the Partnership for Undergraduate Life Sciences Education (PULSE) will come to train your faculty without charging any fees (<https://pulse-community.org/ambassador>). The two-day Ambassador workshop is based on the principles of facilitated leadership. External and highly trained STEM professionals lead difficult conversations on how to engage faculty on active learning strategies based on the *Vision and Change* report (19, 20). Having external faculty to share their expertise and then leave after two days has helped us to engage departmental members in difficult conversations (e.g., lack of equity and inclusion in STEM classrooms). In our biology department, we conducted the training and now we have a cohesive vision for a revamped curriculum with more active learning strategies that promote student inclusion. Even faculty who were initially resistant to change are now engaged in completing this mission.

Having a local branch of an association like the American Association for Colleges and Universities is also useful, as the fees for regional training are nominal. For example, the Project Kaleidoscope (PKAL) is a national higher education reform center with the mission to empower STEM faculty, especially from underrepresented groups, to transform undergraduate STEM teaching and learning (21). Indeed, PKAL is one of the main STEM forces for equity and inclusion in Puerto Rico and we have a local branch that meets every year for a nominal fee. Our gatherings discuss how to revamp our curriculum with more active learning and critical thinking skills but also explore innovative ways to implement equity in the classroom. Similarly, they have Southern California, Massachusetts, Capital, North Carolina, Ohio, and New York networks. Indeed, the need for faculty to receive training and engage in inclusive excellence only continues to grow, as the number of LatinX students in universities is increasing. In recent years, LatinX students are the only population with a spike in university degree attainment, with 22% of LatinX adults (25 and over) earning an associate degree or higher compared with 44% of all other adults in the United States (22). Currently, one of every five students in the classrooms is from LatinX heritage (22).

### Listening to student voices

Going back to my initial analogy of the microbial mats, these systems persist due to the presence of many exopolymeric substances that glue the different populations in the mats. Students are as necessary as those exopolymeric substances; they are the glue of our institutions, and their voices need to be heard more. To be more inclusive, we need student voices on all the academic boards that are appointed to solve students' issues. As faculty, we often do our planning without understanding students' agendas and interests, and often, what works for us is not necessarily what will work for them. This is why students must be part of the academic conversation. In addition, explicit discussion with students and academicians about inclusion issues is crucial. Even having words to express the feelings helps. For example, words like micro- and macro-aggression, white fragility, implicit bias, and stereotype threat were never part of my training as a graduate student. I think it is imperative we change that and provide all graduate students an appropriate lexicon to describe and counteract the effects of discrimination they experience in a higher education institution. Inclusion training is hard, as it involves dealing with our emotions, but as educators in microbiology, we need to make it a personal priority if we really care about our students' success. Only by having strong communication amongst different populations will our microbiology departments be as inclusive, and consequently, as productive, as a microbial mat.

### ACKNOWLEDGMENTS

I thank all personnel from the Inclusive Excellence (IE) program at HHMI for their emotional and financial support. This work was supported by the IE program from Howard Hughes Medical Institutes (HHMI #GT11071). I also thank my community at the University of Puerto Rico-Humacao for the useful conversations we have had and Dr. Franco Delogu, from Lawrence Technical College, for his insights into the understanding of the psychosociocultural aspects of this reflection. Furthermore, I am extremely grateful to Rebecca Batchelor (University of Puerto Rico-Humacao) for providing useful edits and important feedback on equity and diversity. Institutional Review Board approval number 2018-2019-018. The author has no conflicts of interest to declare.

### REFERENCES

1. Rios-Velazquez C, Casillas-Martinez L, Visscher PT. 2007. Learning geomicrobiology as a team using microbial mats, a multidisciplinary approach. *J Microbiol and Biol Educ* 8:28–35.
2. Dobblin F, Kalev A. 2016. Why diversity initiatives fail? *Harv Bus Rev* July–August: 52–60. <https://hbr.org/2016/07/why-diversity-programs-fail>
3. Asai D. 2019. To learn inclusion skills, make it personal. *Nature* 565(7741):537.
4. Hurtado S, Alvarez CL, Guillermo-Wann C, Cuellar M, Arelano L. 2012. A conceptual framework for diverse learning environments: the scholarship on creating and assessing conditions for student success, p 41–122. *In Smart JC, Paulsen MB (ed), Higher education: handbook of theory and research, vol 27.* Springer, New York.
5. Castellanos J, Gloria AM. 2007. Research considerations and theoretical application for best practices in higher education: Latina/os achieving success. *J Hispanic Higher Educ* 6:378–396.
6. Chun H, Merranda-Romero M, Schwartz J, Pham A, Castro-Olivo SM. 2016. Psychosociocultural structural model of college success among Latina/o students in Hispanic-serving institutions. *J Divers Higher Educ* 4:385–400.
7. Byars-Winston A, Rogers J, Branchaw J, Pribbenow C, Hanke R, Pfund C. 2016. New measures assessing predictors of academic persistence for historically underrepresented racial/ethnic undergraduates in science. *CBE Life Sci Educ* 15(3). <https://doi.org/10.1187/cbe.16-01-0030>.
8. Yosso TJ. 2005. Whose culture has capital? *Race Ethnicity Educ* 8:69–91.
9. Devos T, Cruz T. 2007. Implicit identification with academic achievement among Latino college students: the role of ethnic identity and significant others. *Basic Appl Soc Psychol* 29:293–310.
10. Roberts RE, Phinney JS, Masse LC, Chen YR, Roberts CR, Romero A. 1999. The structure of ethnic identity of young adolescents from diverse ethnocultural groups. *J Early Adolesc* 3:301–322.

11. Casillas-Martinez L, Gonzalez-Espada W. 2019. Cybernetic girls can be pinky: strategies to recruit and retain Latinas into STEM in the context of faculty-to student empowerment, p 33–51. *In* Mack K, Winter K, Soto M (ed), *Culturally responsive strategies for reforming STEM higher education: turning the TIDES on inequity*. Emerald Publishing Limited.
12. Gloria AM, Castellanos J, Segura-Herrera TA, Mayorga M. 2010. Assessing cultural orientation, cultural fit, and help-seeking attitudes of Latina undergraduates. *J Coll Couns* 2:126–140.
13. Cano MA, Castillo LG, Castro Y, de Dios MA, AM Roncancio. 2014. Acculturative stress and depressive symptomatology among Mexican and Mexican American students in the U.S.: examining associations with cultural incongruity and intra-group marginalization. *Int J Advance Couns* 2:136–149.
14. Sampe MC, Dueñas M, Gloria AM. 2019. Latin@ undergraduates' willingness to seek and attitudes towards counseling: an examination of cultural orientation and cultural fit. *J Latinos Educ* 1–16. doi.org/10.1080/15348431.2019.1588735.
15. Garcia G, Okhidoi O. 2015. Culturally relevant practices that best serve students at a Hispanic-serving institution. *Innov Higher Educ* 40:345–357.
16. Caruso JP, Israel N, Rowland K, Lovelace MJ, Saunders MJ. 2016. Citizen science: the small world initiative improved lecture grades and California critical thinking skills test scores of nonscience major students at Florida Atlantic University. *J Microbiol Biol Educ* 17(1):156–162.
17. Cooper KM, Soneral PA, Brownell SE. 2017. Define your goals before you design a CURE: a call to use backward design in planning course-based undergraduate research experiences. *J Microbiol Biol Educ* 18(2). <https://doi:10.1128/jmbe.v18i2.1287>.
18. Hatfull GF. 2015. Innovations in undergraduate science education: going viral. *J Virol* 89(16):8111–8113.
20. Allen D, Tanner K. 2005. Infusing active learning into the large-enrollment biology class: seven strategies, from the simple to complex. *Cell Biol Educ* 42:262–268.
21. McLaughlin J, Metz A. 2016. Vision and change. Why it matters. *Am Biol Teach* 78:456–462.
22. Mack KM, Winter K. 2015. Teaching to increase diversity and equity in STEM (TIDES): STEM faculty professional development for self-efficacy. *In* Weaver GC, Burgess WD, Childress AL, Slakey L, (ed), *Transforming institutions: undergraduate STEM education for the 21st century*. Purdue University Press.
23. Santiago DL, Janette M, Bonilla C, Labandera E. 2019. Latinos in higher education: compilation of fast facts. *Divers Inclusion Law School Higher Educ* 38. <https://arc.accesslex.org/di-law-school/38>