Chapter 7
Exposing the Invisibility of Marginalized Groups in Costa Rica and Promoting Pre-service Science Teachers' Critical Positional Praxis

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7.1 The Costa Rican Context

Dr. Rodriguez (the first author) visited Costa Rica (CR) during his sabbatical in order to explore possible research collaborations. He has previously visited CR and has always been fascinated by the abundant natural beauty of this country and by its citizens' widespread environmental sustainability consciousness. While this may not be the case for every person, Costa Ricans continue to gain admiration abroad for their deep commitment to green energy and for seeking to preserve their country's natural beauty. Almost everywhere you go, recycling is part of the culture, and the CR government continues to make bold moves toward green and sustainable energy. For example, most of CR's electricity needs are met through renewable resources (78.26% hydroelectric; 10.29% wind energy; 10.23% geothermal, and about 0.83% solar and biomass) (Reve, 2020). In addition, the current government has pledged to reach zero carbon emissions by 2050 (CR Government, 2021).

As part of the CR's government ambitious agenda is the recognition that in order to accomplish (and sustain) the country's green energy and economic growth goals, a well-educated citizenry is required. To this end, the Ministry of Education introduced a new set of education standards, *Educar Para Una Nueva Ciudadania* (Education for a New Citizenry, Ministry of Education, 2017). These standards call for the promotion of students' understanding of sustainable development; cultural

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A. J. Rodriguez, R. L. Suriel (eds.), *Equity in STEM Education Research*, Sociocultural Explorations of Science Education 26,
https://doi.org/10.1007/978-3-031-08150-7_7

diversity; critical thinking and creativity; solving real-world problems; collaboration; and global/local citizenship. In fact, there are many similarities between the new Costa Rican (CR) education standards and the US Next Generation Science Education Standards (NGSS, Achieve, 2013). In addition, both countries recognize two major obstacles for achieving their desired goals are: (1) The lack of participation of women and other underrepresented groups in STEM-related fields and (2) The limited opportunities available for teacher professional development in relation to the new standards.

We know that lower achievement and participation in STEM is a persistent trend that starts early in elementary school and this gap broadens through high school and beyond. For example, in the latest results of the Program for International Student Assessment (PISA) (OECD, 2018), CR's 15 years old scored an average of 402 points on the mathematics test, while the Organization for Economic Cooperation and Development (OECD) countries' average score was 489. CR's boys attained 18 points higher score than girls in mathematics and 9 points higher in science. Research studies in the US indicate that the difference in scores between boys and girls do not have anything to do with ability but with the curriculum and sociocultural interactions in the classroom (Rodriguez, 2004, 2015a; Zozakiewicz & Rodriguez, 2007). To put it bluntly, girls, young women and other underrepresented students in STEM simply find the traditional teacher-centered and decontextualized curriculum boring and disconnected to their everyday lives. Here is where the CR's new education standards could play a key role in helping turn this trend around in both the US and CR:

> An education for a global citizen requires that students take an active role, to confront local and global challenges and contribute to a much more just, peaceful, secure, inclusive and sustainable world for all (Education for a New Citizenry, Ministry of Education, 2017).

While this an excellent educational goal, as mentioned earlier, one of the major obstacles obstructing its progress is the lack of effective professional development for teachers. In other words, we know that teachers in both countries—especially high school science teachers—continue to be mainly trained using traditional and canonical approaches to teaching and learning (Alfaro Varela & Villegas, 2010; Navarro-Camacho, 2019). No national survey on teachers' perceptions of their ability to teach STEM-related subjects has been conducted in CR, but in the US, the most recent National Survey of Science and Mathematics Education Report (Banilower et al., 2018) showed that 31% of teachers feel very well prepared to teach science and only 3% feel very well prepared to teach engineering.

It is evident that in order to increase the participation of women and other marginalized groups in STEM, a more systemic approach is needed. Furthermore, several scholars (including the authors) have demonstrated that helping teachers integrate culturally inclusive pedagogy with inquiry-based, hands-on, and minds-on STEM practices is an effective approach for making a long-lasting and significant impact on student achievement, as well as promoting students' interest in STEM-related careers (NRC, 2012; Rodriguez, 2015a; Rodriguez & Morrison, 2019).

Given the high interest in both the United Staes (US) and CR to address common educational goals, and given that both countries were seeking to implement new science education standards, we (co-authors) agreed to implement and expand a mixed methods research project based on a current longitudinal study the first author is conducting in the US. Before we share more details about this project and its findings, we would like to first describe some of the challenges and successes we encountered while seeking funding. One of our goals with this chapter is to encourage university administrators and funding agencies to be more supportive of international research collaborations and recognize the potential for advancing scholarship and common educational and equity goals.

7.2 Seeking Funding: Challenges and Perseverance

In contrast to the impulse for STEM education in the US, CR is promoting STEAM (science, technology, engineering, arts and mathematics) education. However, there are no plans for government-sponsored and systematic teacher professional development, nor for providing schools with the necessary equipment and materials to integrate engineering practices. In short, this is a very similar situation to that found in the US (Rodriguez, 2015b). Since the first author's US-based project mentioned above had a focus on addressing equity, diversity and social justice issues through cross-cultural STEM education, we developed a research proposal to support the implementation and expansion of this project in Dr. Navarro's science methods courses for secondary science teachers. In addition, Dr. Navarro—who is also the Coordinator for the Secondary Science Teacher Education Program at the University of Costa Rica (UCR)—was leading major reform efforts in her program. Therefore, she and her colleagues were excited about our collaboration because their students have not been previously exposed to any professional preparation in STEM/STEAM education or in cross-cultural education. Yet, as mentioned above, the new CR's standards were expecting teachers to be proficient in both areas.

We submitted a research proposal to the UCR's Instituto de Investigación en Educación (Institute of Education Research–INIE) and we obtained enough funding to secure the equivalent of one course release for Dr. Navarro and for hiring a part-time student assistant. This was a significant achievement because funding to support this kind of projects in education is very difficult to obtain at the UCR. In addition, program coordinators at the UCR have significant teaching loads and are often burdened with additional administrative duties—much more than what we encounter in equivalent R1 universities in the US.

Everything was going well, so we were excited about seeking support from Purdue University–the first author's former home institution; after all, Purdue has one of the largest international student populations in the country due to its strong engineering and science programs. In addition, no other faculty from the college of education had an active international research project collaboration with pre-service teachers at the time. Unfortunately, this excitement was short-lived. In fact,

sometimes nothing seems to murder the joy of pursuing an innovative scholarly endeavor more abruptly than discussing such endeavor with a desk-bound university administrator. Instead of celebrating the potential for cultural exchange and scholarship that this project offered, I was swiftly steered to talk to others to ensure that the university's "interests" were protected. When I explained once again that this was a seed project with no material cost to the university, I was given a long form to fill out before our project could be "processed." This is one of the questions from the university's *Sponsored Programs Office*:

> Describe the number and also the nature/intent of previous and/or current agreements or relationships with this institution/entity. Please also describe Purdue agreements with other institution/entities within the same country. Please use this global-linkages database to search.

My response to this question did not hide my frustration:

> This is a ridiculous question. How does this have anything to do with the partnership I'm trying to establish? Why should I be expected to research other agreements between Purdue and other institutions within this country when seeking to establish this one is difficult enough!

This situation was aggravated by our request to have a university official sign a memorandum of understanding produced by the UCR describing the scope of work and responsibilities of the researchers. This was really meant to be more of a formality and a courtesy to keep everyone informed, and the document made it clear that nothing material or financial was expected from my home university. After multiple e-mails repeating the same arguments to multiple people who could not see beyond established forms and archaic procedures, we secured a revised memorandum of understanding from the UCR that just accepted the first author's signature. This enabled us to move the project forward.

Because it became evident that no support was forthcoming to advance our project, we turned our gaze elsewhere in order to secure additional funding. We were surprised and dismayed by the dearth of funding opportunities for international research collaborations like ours. It seems that where funding was available, it was targeted for countries in extreme needs or for developed European countries. Developing countries with a strong democratic history and a commitment to global peace and environmental sustainability do not seem to attract the attention of funding agencies. A short-sighted fact considering how much we could learn from CR—a country that abolished its standing army in 1948 and reallocated those funds to improve public education and health. In addition, CR has one of the most stable democracies in Latin America.

We found out that the Fulbright Scholar Program was about the only option we could pursue, and Dr. Rodriguez applied and eventually received this award. Purdue University does provide support to faculty interested in applying to this program because it is used as an indicator for university rankings, and because this institution was interested in improving its record of faculty receiving these international grants compared to other R1 universities across the US. In any case, we were grateful regardless of whatever the institutional motivation was, but we could not help

lamenting once again that intellectual curiosity, moving beyond ethnocentric understandings of teacher professional preparation, promoting equity and social justice, and so on, were not the driving forces for supporting international collaborations. This realization accentuates even more how essential and unique the Fulbright Scholars Program truly is for promoting international collaboration and cross-cultural understanding (https://cies.org).

7.3 Sociotransformative Constructivism and Critical Cross-Cultural Education

The Fulbright grant enabled us to make our project longitudinal; that is, we were able to work with the same cohort of secondary pre-service science teachers through the three consecutive science methods courses (over three semesters) required by the UCR teacher preparation program. We will describe more details about the teacher education program in the next section. Here, we wish to briefly describe the theoretical framework guiding our project.

Our study is informed by *sociotransformative constructivism* (sTc)—a framework that merges critical cross-cultural education (as a theory of social justice) with social constructivism (as a theory of learning) (Rodriguez, 2011/1998). Therefore, we are in agreement with Lev Vygotsky's (1978) conceptualization of learning as a social activity dependent on the context and experiences of participants. This implies that an individual's language (in whatever form and including symbolic language), culture, and experiences mediate what and how that person learns during social interactions with others. In our view, if we believe that learning is influenced by the participants' prior experiences and social interactions, then the construct of power must be considered as one of the key mediating factors. This is where sTc serves as a bridge between social constructivism and critical cross-cultural education because the individuals' positionalities determine their access to (and influence upon) the culture of power. For example, a female, dark skin Latina, physics teacher teaching advanced high school physics courses with a focus on gender equity in STEM in predominantly Anglo, male high school classrooms might experience different power dynamics than an Anglo male counterpart. Thus, sTc raises awareness about how an individual's multiple positionalities—be it ideological, socioeconomic, academic, ability status, sexual expression, skin color, etc.— might influence their, his or her access to power, and how power mediates teaching and learning interactions.

This critical lens for understanding social constructivism is congruent with critical approaches to multiculturalism (May & Sleeter, 2010). In other words, sTc rejects neoliberal notions of multicultural education focused on "acceptance," "tolerance," "diversity," "awareness," and superficial understandings of "equality." Instead, sTc promotes critical cross-cultural understandings of not only how webs of oppression obstruct access to meaningful education for everyone, but it also promotes the dismantling of the systemic roots that sustain those webs of oppression.

To this end, sTc is composed of four interconnected elements: *the dialogic conversation, authentic activity, metacognition, and reflexivity* (Rodriguez, 2011/1998). These constructs are not "stages," or "phases," nor any kind of traditional (Western) linear thinking ensemble. They are simply conceptual devices meant to facilitate teaching and learning for transformative action through culturally and socially relevant pedagogical strategies and curriculum. Thus, any one or more of these four elements can be enacted at any time in response to the challenges and opportunities typically found in school contexts. (For more information on how sTc has been deployed in various learning contexts see: Morales-Doyle, 2017; Rodriguez, 2015a, 2021; Tolbert et al., 2018).

While we enacted all four elements of sTc in our project, for this chapter, we focus on *reflexivity* and the *dialogic conversation* since these are most relevant for discussing teacher identity development in our research context. The dialogic conversation is primarily based on Mikhail Bakhtin's (1986) construct of *dialogicality*. This construct enables us to better understand the complex process of meaning-making among individuals because it problematizes taken-for-granted assumptions about listening and speaking or 'just engaging in dialog.' For example, in educational research, it is common to hear about the importance of promoting: students' collaboratively work in groups, the open discussion of their findings, and the development of their scientific-argumentation-from-evidence skills, and so on. However, this approach assumes that all that is needed is for teachers to organize students in small groups, and then complex meaning making will just happen. We believe this process is much more complicated. Using Bakhtin's dialogicality construct, we argue that teachers and students also need to understand how their identities or multiple positionalities (i.e., ethnicity, gender expression, sex, experiences, language abilities) influence what and how they think. In short, a dialogic conversation does not involve just listening, reading or deciphering words or symbolic language, it involves understanding how the speaker's and the listener's voices harmonize (construct meaning together) or collide (creating tension and dissonance). This is where sTc advances the notion of dialogicality by directly addressing issues of power. In other words, teachers (with their privileged, authoritative voices) are perfectly poised to guide and encourage dialogic conversations through which students (and their teachers) engage in meaningful and respectful conversations. In these dialogic conversations participants are not just hearing words, they are listening and paying attention to what is being said, as well as who the speaker is (i.e., the speaker's positionalities). For the dialogic conversation to work effectively, additional efforts are needed to ensure that everyone in the dialogic context (e.g., classroom community) knows one another well and are interested in building trust and respect for each other.

We argue that for teachers to be able to promote dialogic conversations in their classrooms, they also need to have a strong sense of their own identity (or multiple positionalities), and in our view, identity and *reflexivity* are closely linked and always influenced by one another. Thus, for sTc, reflexivity involves engaging in an on-going process of critical self-reflection on how one's own multiple positionalities determine one's actions (or inactions) (Rodriguez, 2011/1998, 2015a). In order

to better distinguish between espoused beliefs (good intentions/heightened awareness) and beliefs in action, we prefer to use the term *critical positional praxis (CPP)*. That is, CPP is the enactment and public manifestation of our sense identity; how we perceive other people's identities; and of the meanings produced by those interactions. Thus, this approach adds a transformative action component to Crenshaw's (1991) notion of intersectionality. That is, Crenshaw articulates that our identities are never singular, but multiple and determined by various sociocultural positions (i.e., gender expression, socioeconomic status, education, sex, physical ability, ethnicity, language abilities). However, what do we do with increasing one's self-awareness? How does this translate into actions that impact our everyday lives, as well the lives of others around us? We suggest that CPP answers these questions. For example, a strong sense of identity (or of our multiple positionalities) might provide us with the resilience and determination to pursue our goals. However, if others, who are in higher power positions, perceive us as incapable and unworthy due to their perceptions of who we are, they will unfairly make our goals so much harder to achieve. Thus, CPP provides the toolkit to recognize that our identity is not only defined by who we think we are, but by how others construct representations of our identities based on those individuals' understanding (or lack thereof) of their own identity

This relationship between our own sense of identity and how we are constructed by others plays a significant role in our personal, psychological, educational, and professional growth. Therefore, CPP enables us to take action by ensuring that others perceive us as I we would like to be identified (e.g., Latina not Hispanic; or gay not heterosexual; or multilingual not someone with an accent; physically able not disabled because of hearing challenges; or professor not international graduate student; and so on). Similarly, CPP enables us to be more mindful (through reflexivity) about how we construct other peoples' identities and how we interact with them based on those perceptions. In short, the difference among reflexivity, identity and CPP is that while all of these constructs are interlinked and influenced by one another, reflexivity and identity configure and provide meaning to a present version of ourselves in a given time and context. Thus, reflexivity and identity are primarily private processes occurring in our minds. Whereas CPP, on the other hand, is the public manifestation of the insights gained through our sense of identity and reflexivity; in fact, CPP are actions (on inactions) that express who we are.

For our project, we sought to assist pre-service teachers in their identity development through reflexivity, and to promote their CPP through their collaborative work, lesson planning and teaching. We are aware that much has been written on teacher identity in various fields of inquiry (Jupp et al., 2019), and that the construct of teacher identity has gained more interest in science education in recent years (Avraamidou, 2014). Elsewhere, Rodriguez, Tolbert and Mark (in press) address some of the issues associated with the current research on science teacher identity development, such as the modest analyses of this construct in relation to issues of power dynamics, systemic racism and other forms of oppression.

While a comprehensive critique of the literature on the construct of identity is not the focus of this chapter, we sought to articulate how we theorize the interactions

among identity, reflexivity, and critical positional praxis in our efforts to support the participant pre-service teachers' professional development as culturally responsive teachers. We also explained that one of the primary means through which we sought to facilitate all of these processes is through dialogic conversations with the participants. In the next sections, we share highlights from our research findings that more specifically illustrate how the sTc elements of reflexivity and the dialogic conversation were enacted to promote the pre-service to teachers identity development and critical positional praxis.

7.4 Methodology

7.4.1 The Costa Rican Secondary Science Teacher Preparation Program

As mentioned earlier, we follow the same cohort of secondary pre-service teachers (PSTs) through three required science methods courses: *Methodology in the Teaching of Sciences* (which is similar to the typical science methods courses taught in the US with an emphasis on pedagogy and developing curriculum). *Teaching Experience in Sciences* is like an extended science methods course that also includes their school-based teaching placements. The third course, *Seminar in the Teaching of Sciences*, involves PSTs learning about research methodologies and conducting a small research project in school-based placements. This is a very unique approach. In the US, PSTs typically have only one science methods course, and they do not have a methods course associated with their final school-based placements. The latter usually represents the last semester of PSTs teacher preparation in the US. However, the UCR's teacher education program requires PSTs to take a research methods course that aims to enhance PSTs' understanding of science pedagogy, curriculum and theory in various school contexts. Interestingly, teacher graduates often continue their studies and pursue a *lincenciatura* or licentiate degree for two additional years. This additional certification enables them to secure a higher remuneration and status when assigned a teaching position (in Costa Rica the assignment of teaching jobs at public schools is centralized and administered by the Ministry of Education). PSTs also have the option to pursue other graduate degrees, such as a master's or (with less frequency) doctoral degrees. Important to note is that none of the Costa Rican universities offer doctoral degree with specialization in science education.

7.4.2 Participants

Our project included 17 secondary pre-service science teachers. Nine of them are women (52.9%), seven are men (41.2%), and one is Other (5.9%). Ethnic identity is a key construct being investigated in this study, so we address it in more detail in the next sections. However, at this juncture, it is important to note that 14 PSTs identify themselves as Mestizos/as (82.4%); two as Mulatos/as (0.12%) and one as Other (0.06%). The first author is a Latino (male), and the second author is Mestiza (female).

7.4.3 Research Tools and Analysis

We used a variety of quantitative and qualitative research tools that included pre-post surveys. In addition to the general demographics questions, the survey included questions about whether the participants have ever experienced any form of discrimination based on gender, skin color, sexual orientation, socioeconomic status, or other factors. We also sought to monitor changes in the pre-service teachers' self-efficacy. That is, we used a Likert scale and short answers questions (Plowright, 2011) for participants to share their perceptions of preparedness to integrate STEAM and cross-cultural education in their science teaching practice. We also sought to evaluate any changes in their perceptions of preparedness to teach in any of the core science areas biology, physics, geology and chemistry. In CR, secondady teachers are certified to teach all of the science courses. The pre-survey was administered at the beginning of the first course, and a post-survey was administered at the end of each of the three methods courses to monitor knowledge growth and changes in the PSTs experiences. Same gender focus group interviews (4 females and 4 males) were conducted at the end of each methods course, and we also gathered data from teaching observations, review of artifacts (lesson plans and students' class work), and field notes. For this chapter, we are primarily drawing insights from the ethnographic analysis of the pre-post surveys data, short answers, and focus group interviews (Spradley, 1979); therefore, we are not sharing here a full analysis of the quantitative and qualitative data we gathered over the course of three semestes. Our goal is to provide a critical auto-ethnographic analysis of how our collective understanding was impacted as issues regarding notions of ethnic/cultural identity arose through our dialogic conversations with each other and with the PSTs. Critical auto-ethnography (Marx et al., 2017) is a methodological approach well-suited for this reflexive re-telling of our encounters with dominant discursive practices (from the US and CR), and how the insights gained helped guide our study.

7.5 Findings

Overall, preliminary analysis of the quantitative and qualitative data shows significant gains in the PSTs perceptions of their abilities to integrate cross-cultural and STEAM education in their practice. However, for this chapter, we focus on insights gathered on ethnic/cultural identity development and its potential impact on future teachers' abilities to establish the kind of culturally inclusive and socially relevant science/STEAM classrooms everyone expects them to create. Thus, we begin by explaining how two elements of sTc—the dialogic conversation and reflexivity—guided these insights.

7.5.1 The Dialogic Conversation and Reflexivity in Action

Because this project is an extension of an ongoing research being conducted by the first author, we asked participants to disclose their ethnic identity associations as it is a common practice in the US. Interestingly, this presumed to be 'common' question in the US context stirred unexpected reactions and long discussions, which in turn inspired the writing of this chapter. Originally, the first author (Dr. Rodriguez) sought to include the same open-ended questions he uses in the US context in order to explore how pre-service teachers (PSTs) would identify themselves without having to be constrained by the typical pre-designated ethnic/cultural (racial) boxes one often finds in surveys. In addition, since Dr. Rodriguez identifies as Latino (originally from South America), as an immigrant citizen of the United States and Canada, and as an English and multilingual learner, traditional ethnic identity questions often feel awkward and stuck in colonial framings. That is, these questions tend to focus more on superficial shades of skin color and 'racial' labelling instead of celebrating individuals' rich ethnic and cultural roots (Rodriguez, 2004, 2015c). Therefore, he suggested to ask the Costa Rican (CR) participating pre-service teachers the open-ended question: *What ethnic/cultural group(s) do you identify with?* In the US context, the answer to this question is very useful for guiding PSTs in the exploration of their own ethnic identity as future teachers who will most likely be working with very different cultural groups than their own. Similarly, Dr. Rodriguez sought to explore the CR participants' ethnic identity positionalities. However, Dr. Navarro (the second author) indicated:

> Here we would not know what to answer, and there are no indigenous students in our program. In addition, if we write down Caucasian, Afro-descendant or Indigenous, we all have those genes, we do not consider ourselves Caucasian, but Creole (Criollos) or Mestizo (Field notes, Year I).

Dr. Navarro, who identifies as Mestiza, and born in Costa Rica, raised this interesting point. Our research assistant, who also identifies herself as a CR Mestiza, agreed. They suggested to drop this question altogether from the survey because it would cause confusion. We decided to exclude the ethnicity question, but the

Table 7.1 Responses to the survey question: *Have you had any experience in which you have felt discriminated against because of your: [choose the relevant answer (s)]*

Category	Number of respondents	Percentage of respondents
Gender?	5	35.71%
Sexual orientation?	1	7.14%
Skin color/ethnicity?	0	0.00%
Socioeconomic status?	4	28.57%
Other?	4	28.57%

Latino-US centric framing of the question caused us to continue a dialogic conversation as we were all surprisingly puzzled by each other's reaction to it.

One related question that we did keep in the survey was: *Have you had any experience in which you have felt discriminated against because of your: [choose the relevant answer (s)]: a. gender; b. sexual orientation; c. skin color/ethnicity; d. socioeconomic status; e. other*. Table 7.1 summarizes the responses (Most but not all 17 participants answered this question). As it can be observed, the pre-service teachers, who were mostly women (53%), had direct experience with sexism, one participant explained:

> Some people think that women are not capable enough to develop in scientific fields and that is why I have heard comments from people who say that women should not teach science because they do not know the same as a man. (Pre-survey I, short answer questions)

Another participant illustrates the multiple discrimination one often encounters while inhabiting multiple intersectionalities:

> I am from a small town and people believe that women should just have children and not dedicate their lives to just studying, also throughout my life I have experienced discrimination for not having luxury clothes or the fashionable cell phone even here at this university it has happened to me. (Pre-survey I, short answer questions).

Almost a third of the participants (28.6%) explained that they have experienced discrimination based on their socioeconomic status. Interestingly, however, no participant indicated that they have been discriminated based on their skin color/ethnicity. However, racism unfortunately continues to be a very significant oppressive factor for Black, AfroLatinos(as), and Indigenous peoples in Costa Rica and elsewhere (INEC, 2011; United Nations, 2013).

The absence of comments regarding racial discrimination and the apparent long-standing lack of pre-service teachers from African and Indigenous cultural backgrounds enrolled in the University of Costa Rica's (UCR) teacher education program re-triggered the research team's dialogic conversation about whether to ask participants to disclose their ethnic/cultural associations. We decided to pursue this additional question, and just the process of doing so, as well as the participants' responses triggered transformative dialogs for all of us (researchers and pre-service teachers).

First, as we discussed what would be appropriate ethnic/cultural categories to include in our ethnicity question for the participants, it was striking to observe the similarities in the use of colonial and color-coded discourse between the US and CR

Table 7.2 Costa Rican official ethnic categories[a]

Ethnic category	Definition
Black or Afro-descendant	People who mainly recognize in their identity the cultural roots of African descent and their diaspora.
Mulatto(a):	The people who recognize mainly in its identity the roots cultures of African descent and their diaspora from one of his parents.
Chinese	People with ancestry from the People's Republic of China, including Taiwan and Hong Kong. Does not include people of other Asian ancestry.
White or Mestizo(a)	People who mainly identify with the legacy of Hispanic American culture and history. This also includes people who identify with the legacy of European or Anglo-Saxon culture and history.
Indigenous	Any person identifying as a member of one or more of the various indigenous ethnic groups of Costa Rica. (These are explained in more detail in the next section).
Other	People who self-identify with any ethnic group not mentioned in the previous categories.

[a]Categories translated directly from those indicated in the INEC, 2010 (Census Taker Manual, p. 142)

(see Table 7.2). In other words, according to the CR National Institute of Statistics and Census (INEC, 2010) colonial terms such as, Mulatto, Black, and White endure.

For Dr. Rodriguez, who identifies as a Latino, and who has consistently refused to use colonial, color-based ethnic categories in spoken or written forms (Rodriguez, 2004, 2015c), the discovery of this differentiation by CR national census was astonishing in two significant ways. First of all, it provoked critical reflection on ethno-US centric notions of what it means to be Latino once again. In other words, as a dark-skinned Latino, he first experienced racial discrimination as an international student in Canada and became aware that a different shade of skin color can make a person an object of hate. This experience reshaped his Latino identity to this day. Unfortunately, even decades later, and as a full professor, he continues to experience racism in and out of academic contexts. In addition, after working at various universities in the US, he has become more aware of the rich diversity within the US Latino/a community (e.g., Chicanos/as, Hispanic, Latinx, Mexican Americans, Caribbean Latinos, Puerto Ricans, Dominicans, AfroLatinos/s, Latino/a, and more). However, the official differentiation in CR of Afro-Latinos as Mulattos/as or Afro-descendants/Black, and the confluence of White with Mestizo/a (Table 7.2) further problematizes the established demographics designations in the US and taken for granted notions of what it means to be Latino/a. This is particularly important for teachers to consider when working with students in culturally and linguistically diverse contexts. Second, for Dr. Navarro, our dialogic conversation on this issue provoked her to reflect on the persistent absence of Indigenous and Afro-descendant students in her teacher education program since the ethnicities of pre-service teachers enrolled in her program have not been monitored. This also caused us to wonder what policies (if any) were in place by the College of Education and UCR in general to recruit and retain students from marginalized backgrounds (we share findings on this issue in the next section).

After asking the participating pre-service teachers to share their chosen ethnic/cultural identity using the official CR census categories (see Table 7.2), it was fascinating to observe the productive dialogic conversations that it caused. Again, because this project is guided by sTc, these are the kind of critical and reflexive discussions that the dialogic conversation and reflexivity promotes. These findings are best represented in the participants' responses during the focus group interviews (pseudonyms are used throughout):

> I had a problem with the ambiguity because in the option of White, it also said Mestizo; that is, I do not consider myself White because I am Latino, let's say but I wanted to mark Mestizo, so I wanted to mark both (Luis, FG I, p. 4).

Other students in the same focus group expressed similar hesitation and confusion, "I was also confused because I didn't know how to classify myself in relation to the categories in the survey, so I chose Mestizo" (Pedro, FG I, p. 4). Another dark-skin student did not find a category that best represented him, so he chose Mestizo as he understood this category more a mixing of multiple ethnicities, he adds:

> I have a great grandmother who is from China from my father's side, and from my mother's side I have a great grandmother who is from Germany, so for me it is more the mixing of everything (Javier, FG I, p. 4).

We conducted separate focus group interviews by gender in order to explore any possible gender-based issues across the project. However, in regard to this question, we found the same level of ambiguity and hesitation among the female students. For example, Veronica explains:

> I believe that the classification made by the INEC (the census institute) is not the one with which I feel most identified, because there is no specific classification with which I identify myself, which is between Mulatta and Mestiza. . . in our education program, they do not teach us how to identify with something specific. We know that we are a mixture and I think that knowing that we are a mixture, we do not identify with something specifically. I think that because of social networks and because of the information bombshell, I think that being Latino is very important first and I think that is what most people classify into, but between Mulatto and Mestizo, taking into account that we have more part, let's say, of America than from the other continent but I do not feel that it is an accurate classification (Veronica, FG I, p. 3).

Carmen, another participant, agreed with Veronica, and expressed a common reaction among students, "It is curious because until you asked me this question, no one had asked me, I had never thought about it, I have always considered myself a mixture of everything and very similar on what Veronica said, it would be like a Mestiza, is what I, through the education I have received over the years, is the word I find to describe myself according to that (Carmen, FG I, p. 3). Another student, Maria, expressed less hesitation,

> Well, I think that regarding this question I have had no doubt that I classify myself as Mestiza, I have always had that very present, and there is even a curious story in my family where there is a great-great-grandmother who was completely an Indigenous person. . . That's why I have that certainty that there is Indigenous blood in my veins, so I qualify myself as Mestiza (Maria, FG I, p. 4).

It is important to note that all three of these students, based on their physical appearance, would be perceived as White in the US or in Costa Rica, but their chosen identities are Mestizas. These findings further demonstrate the complexity of better understanding our own ethnic/cultural identities, as well as how these understandings are influenced by how others perceive us. Thus, our identities are not determined by government-designated fixed categories, nor by other people's perceptions of which possible category might make them feel less threatened or comforted in our presence, our identities are ultimately embodied by the steps we take to help others see us through our eyes. To accomplish this, we must first develop a strong sense of critical positional praxis (CPP), and as educators, this is an essential first step in becoming an inclusive and responsive teacher. This is also congruent with current education reform efforts in both CR as well as in the US. That is, as mentioned earlier, science teachers are expected to promote critical thinking to address real world problems, cultural understanding, sustainability, and global citizenship (Education for a New Citizenry, Ministry of Education, 2017; NRC, 2012). However, we argue that to promote cultural understanding and global citizenship, teachers must have a well-grounded and critical understanding of their own ethnic/cultural identities.

Now, given that participants (just like PSTs in the US) expressed that they had very limited exposure to university courses with a focus on cross-cultural education, and much less on the critical integration equity, diversity and social justice issues in science/STEAM, we took steps to engage them multiple activities throughout the project that did just that. For an example of a complete activity that also modeled how to integrate a culturally responsive and responsible engineering design process see Rodriguez (2021). In addition, we used insights from the aforementioned findings to assist students make relevant connections between the contributions of Indigenous and Afro-descendants individuals to STEAM. We also continued to encourage reflection on their own ethnic/cultural identities as future teachers who would most likely be placed in spaces where such a diversity will be present. In Costa Rica, graduates of the teacher education programs are assigned to available teaching posts around the country. This means that some postings could be in rural communities with higher number of Indigenous students, or in more populated areas with a higher population of Afro-descendants.

While our project is on-going, preliminary quantitative and qualitative data analysis continue to show significant growth in the pre-service teachers' perceptions of their ability to integrate critical cross-cultural and STEAM education. Participants also indicate that they find integrating equity, diversity and social justice issues the most challenging since this is the first time they are exposed to this approach. This concern is the same as that expressed by pre-service teachers in the research literature due to their similar prior academic preparation in science as canonical, Western and decontextualized (Navarro-Camacho, 2019; NRC, 2012; Rodriguez, 2015a). Nevertheless, we are excited to observe that all PSTs were consistently making progress in their efforts to enact their CPP by more purposely making connections between equity issues and their students' everyday lives. Similarly, the PSTs were

also seeking to integrate the contribution of traditionally underrepresented ethnic groups to science/STEAM.

7.5.2 The Costa Rican Sociocultural Context and the Invisibility of Marginalized Groups

As we became more intrigued by our findings regarding the participants' conceptions of their ethnic/cultural identities, we also wondered about what, if any, policies the UCR College of Education and the UCR had in general to monitor, recruit and retain students from traditionally marginalized cultural backgrounds. After all, one of the principal goals of the UCR for 2021–2025 quinquennial is to "strengthen the institutional strategies that favor and promote equity in the admission process" in order to "promote affirmative actions that favor equity in the admission of traditionally excluded and vulnerable populations" [Políticas Institucionales 2021–2021, Eje III Cobertura y Equidad, política 3.1]. In this section, we share what we discovered and the actions we took to support transformative change (critical positional praxis).

Once we identified the official ethnic categories used by the CR census institute, before posing the ethnic/cultural identity question to participating pre-service teachers, we wanted to make sure to use the same categories deployed by the UCR. We contacted the Vice-Provost Office for Student Life (Vicerrectoría de Vida Estudiantil), and we were surprised to learn that the UCR *does not* consistently monitor ethnic categories because this information is considered "sensitive." After several attempts, an official shared that in the academic year of 2015–2016, the number of Indigenous students was 98. No other enrollment information was available for this ethnic group for other academic years. Considering the aforementioned mission of the university to provide educational opportunities to all members of society, this policy essentially renders invisible the most vulnerable and marginalized ethnic groups in the country. Furthermore, this policy also contradicts the aforementioned national education reform efforts that call for the increase in participation and success of traditionally underrepresented groups in science and engineering. It is well established in the literature that this type of invisibility increases rather than reduces discrimination, because it prevents rigorous and consistent analysis that allows informed decision-making based on data. (Rodriguez, 1999; Rodríguez & Mallo, 2012).

We wondered if other major public universities were also implementing a similar invisibility policy. Table 7.3 shows that all other universities invisibilize Afro-descendant students, with the exception of the National University. While the UCR appears to be the only one who invisibilizes both Indigenous and Afro-descendant students. All the other universities monitor the enrollment of Indigenous students, and the distance learning university (UNED) has a special program to support indigenous students, who often reside in very remote areas.

Table 7.3 Number of newly admitted Indigenous and Afro-descendant students in the country's public universities, school year 2019

Ethnic Category	University of Costa Rica (UCR)/ Universidad de Costa Rica	National University (UNA)/ Universidad Nacional	Technology Institute of Costa Rica (TEC)/ Tecnológico de Costa Rica	State Distance Learning University (UNED)/ Universidad Estatal a Distancia	National Technical University (UTN)/ Universidad Técnica Nacional
Indigenous	98[a]	54	34	698	11
Afro-descendant	No informacion registered	154	No informacion registered	No informacion registered	No informacion registered

Source: Authors' review of statistics from the registry or information offices of the UCR, TEC and UNA and personal communication with a UTN official

[a]According to a university official, this information corresponds only to the year 2015–2016. No information was available for other years

These findings are alarming because they clearly demonstrate a systemic pattern of invisibility across public universities that contradict well-intended national policies of inclusion.

In Latin America, just like in the US, there is a strong correlation between ethnic groups' education and socioeconomic status (NRC, 2012; Senior Angulo, 2007). In this sense, educational exclusion has a severe impact on people's quality of life, as it is one of the main mechanisms of social mobility. In addition to invisibility, the data shown in Table 7.3 also exposes the gross underrepresentation of marginalized groups in institutions of higher education. According to the last national census, the percentage of Indigenous Peoples is 2.47% (the total population of the country is 4.3 million, INEC, 2013). Even though this percentage may appear small, it includes eight different indigenous groups with distinct languages, cultures and territories who enrich the unique cultural diversity of the country (and of the planet). Although important efforts have been made in Costa Rica to achieve basic literacy, the latest data indicate that 20.20% of the population has no education or has not completed primary school. The latest national census also indicates that 10.4% of the Indigenous population cannot read or write in Spanish, and this ethnic group's average formal schooling is around 5.7 years, which corresponds to incomplete primary school. Given that there is a correlation between schooling and employment, in the Indigenous population the unemployment rate is around 59.3%, and the 40.7% who have formal employment work mainly in agriculture (i.e., autonomous crops and husbandry) (INEC, 2011).

In the case of Afro-descendants, they represent 7.8% of the total CR population according to the national census (INEC 2013). More specifically, 6.7% of the population self-identify as Mulatto/a and 1.1% identify as Black. In terms of education, 13.8% of the Black population and 20.8% of the mulattos/as have no education or completed primary school. This percentage increases to 38% in rural areas for both

cases. Regarding school dropout, 68% of Afro-descendants between the ages of 6 and 24 are enrolled in an educational institution, with the attendance and resilience of women being greater. A revealing fact is that only 56.7% of Black men between the ages of 6 and 24 are enrolled in the formal education system, the lowest percentage recorded among all population groups. Regarding higher education, only 9.3% of the 25-year-old Afro-descendants have completed their studies, compared to 16% of the White or Mestizo/a population of this same age group (United Nations, 2013).

Returning to the construct of teacher ethnic/cultural identity, why is any of this information relevant to the aims of this chapter, as well as to the aims of our research project with secondary science pre-service teachers? We argued that *all* of it is absolutely relevant. First of all, since this project is guided by sTc, one of our main goals is to help pre-service science teachers become effective cross-cultural responsive and inclusive teachers. This cannot be achieved without fully understanding the institutional and cultural context in which we are currently working as teacher educators, and without fully understanding the cultural school contexts in which the pre-service teachers will likely find employment. Second, in order to promote critical cross-cultural awareness, everyone (instructors and students) must engage in an examination (reflexivity) of how our multiple positionalities might facilitate and/or impede our work as equity-driven instructors. Through the dialogic conversation and reflexivity, we propose that these kinds of critical discussions can be promoted openly in order to help pre-service consistently make important connections among curriculum, pedagogy, equity, diversity and social justice issues, as well as with their students' culture and experiences.

Another important aspect promoted by sTc is critical positional praxis or transformative action. This action can occur at the individual and/or community level in and out the classroom. The main goal being not to just to be a passive observant in one's own or other people's lives (either as a researcher, instructor or student). Instead, the goal is to actively apply new knowledge and insights to effect transformative change (agency). Therefore, as faculty members, we wanted to model how to promote long-lasting change and student advocacy to the participating pre-service teachers by using the new insights gathered regarding the contradiction between the university inclusive policies and the invisibilization of marginalized groups. We share these efforts next.

7.5.3 Transformative Action: Seeking Policy Changes and Raising Cultural Awareness

Our findings regarding the invisibility of marginalized ethnic groups gathered a lot of interest from various sectors of UCR. We met with a representative member of the Consejo Universitario (CU, University Council). The CU serves a similar function as a university senate does in the US, but with much power. That is, based on Rodriguez's personal experience as a former university senator at various

universities in the US, and as the former Chair of the University Senate at Purdue University, University senates in the US tend to have very little power to influence major university policy changes.

During our meeting, the CU Member offered to write a resolution based on the data we shared on the invisibility of marginalized groups by UCR and other universities. He was confident that his resolution would receive strong support and that it should prompt the university administration to take action. The eight-page resolution argues in detail the need to make significant changes using already established inclusive university policies. In addition, the resolution draws attention to significant Latin American and United Nations' human rights policy documents.

In short, the resolution calls upon the UCR Administration to:

1. Recognize that the Costa Rican population is multiethnic and multicultural and to identify these groups.
2. Acknowledged that in the national territory and within the university community there are groups of vulnerable people who are not currently being recognized.
3. Implement a fixed mechanism throughout the school year that allows continuous monitoring of these ethnic populations within the university, so that eventually different indicators can be developed and affirmative action taken in favor of them (draft resolution, CU x-2021, p. 7).

During the time of writing this chapter, the resolution was being submitted for consideration. In any case, we were pleased that through CPP, we went beyond raising cultural awareness and reflection among the project's participants and university officials, we instigated transformative action that could lead to significant and long-lasting policy changes and practices.

7.6 Conclusion

We have shared findings from an on-going research project with secondary science pre-service teachers (PSTs) at the University of Costa Rica. While the focus of this study was to enhance PSTs' understanding of how to integrate critical cross-cultural pedagogy and curriculum with STEAM (science, technology, engineering practices, arts and mathematics) education, the emphasis of this chapter is on the importance of teacher ethnic/cultural identity development. Because our project is guided by sociotransformative constructivism (sTc), this framework enabled us to zoom in on teacher ethnic identity as this construct unexpectedly became a significant and puzzling point of dissonance among the research team and participants. Guided by sTc's dialogic conversation and reflexivity, the research team took steps to investigate and deconstruct taken-for-granted understandings of what we meant by ethnic/cultural identity from both the US and CR's perspectives. We also explored the role teacher identity development can play in becoming an effective culturally responsive and inclusive science teacher dedicated to advancing social justice issues. The insights gathered from our analysis strengthened the direction of our project and our

ability to better assist PSTs explore their own ethnic/cultural identity (or multiple positionalities).

Our findings also show that these efforts helped PSTs build better conceptual, pedagogical and practical connections as they were being exposed to integrated cross-cultural education with STEAM science activities. This transformative aspect, or critical positional praxis, was evident in the PSTs efforts to purposely integrate in their lesson plans and practice teaching: gender issues (e.g., guiding discussions with their students about the low participation of women in STEAM); the contributions of Indigenous and Afro-descendant peoples to science/STEAM; how socio-economic status affect access to science education, health, and other resources (e.g., clean water); the relationship between environmental and social class issues, and many other aspects. We are currently analysing this component of the larger study, but it is consistently clear that the PSTs moved from seeing science as a canonical and decontextualized content knowledge to seeing science as a culturally and socially relevant subject that can (and should) be connected to students' everyday lives. This perspective then requires a better understanding of students' and one's own ethnic/cultural identity (or multiple positionalities). Becoming critically aware of how one's own ethnic/cultural identity influences interactions with others can facilitate learning for understanding and transformative change.

Congruent with the notion of critical positional praxis (CPP), or the space where we choose to turn new insights gathered from reflexivity and dialogic conversations into transformative action, we also sought to impact a taken for granted policy regarding the invisibility of marginalized groups at the UCR. In fact, this policy (which seems to stretch across other universities in CR) contradicted the country's new education reform efforts and the UCR's own policies for increasing the participation of traditionally marginalized groups in STEM-related fields (and higher education in general). By *not* monitoring the number of Afro-descendants/Black and Indigenous Peoples enrolling at the university, the UCR was de-facto invisibilizing these ethnic groups and making it impossible to provide any services and support to increase recruitment, retention and success.

Our CPP efforts resulted in the submission of a resolution to the University Council (a faculty-led representative body) by a representative member who took interest in this issue. The resolution was written in hope to change the invisibility university policy and institute significant monitoring and support mechanisms for marginalized student populations instead. We also hoped that these efforts served to illustrate to the participating PSTs how CPP can lead to significant and long-lasting change if we choose to act on insights gathered through reflexivity and dialogic conversations.

We wish to also stress and revisit the challenges we first encountered when seeking to secure support for this project. Funding agencies and universities should provide more opportunities for funding these types of international collaborations. The multiple points of inflection that international collaborations could generate to advance science/STEAM teaching and learning should not be taken for granted. For instance, the analysis shared in this chapter was triggered by a single and common US-centric expectation: to ask participants to share their ethnic/cultural identity.

This "simple" question turned out to be much more complex, interesting and impactful than we ever expected in this CR context. Similarly, these findings speak to the importance of improving recruitment and retention efforts of traditionally marginalized groups in science education (and teacher education in general in both countries). One cannot help wonder how much richer and complex our dialogic conversations with one another and the PSTs about ethnic identity would had been if we have had pre-service teachers who identified as Black, Afro-descendants, Afro-Latina/o or Indigeneous in our classes. This is an issue that the first author continuouly raised at his former home institution for 9 years where the elementary pre-service teacher population consistently is about 98% middle-class, monolingual, female, and of Anglo-European descent (or White as most of them self-identify). Having cultural diversity in the classroom (at any level) that mirrors that of the country can facilitate multiple entry points for dialogic conversations and for personal and professional growth.

In sum, our findings reinforce multiple calls for teacher education programs to improve their recruitment and retention efforts of culturally underrepresented students, as well as to make identity development a significant component of their commitment to the professional preparation of teachers as responsive and culturally competent professionals.

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