Chapter 5
International Perspectives on Science Education Research in Multicultural and Multilingual Contexts

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We dedicate this chapter to the memory of Audrey Msimanga who passed suddenly away in June 2021. Prof Msimanga was a dedicated scholar, devoted colleague and mentor, and caring friend.

5.1 Introduction

The authors of this chapter came together as a panel in the ESERA2019 conference to examine and discuss the issue of cultural and linguistic diversity in science education research across the globe. We come from different countries where there are long-standing and open conflicts in education related to culture and language preservation. We all have experience in doing science education research in either multilingual or multicultural science classrooms. Building from our collective

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dialogue, in this chapter we first provide some data on cultural and linguistic diversity in science classrooms and science education research journals globally. We later discuss ways to develop a more culturally and linguistically relevant science education research that addresses the complexities of our diverse science classrooms. Although there are many ways to do so, we have chosen to focus on science education research methodologies, international networks and collaborations, and policy development.

5.2 Cultural and Linguistic Diversity in Science Classrooms

Students' cultural and linguistic diversity continues to increase globally. Certainties about clear distinctions in ethnic group, culture, religion, and language are untenable since individual students can no longer be bound to particular forms of diversity. This shift has been termed *superdiversity*, and it is changing the way educational research is conducted in relation to multicultural and multilingual classrooms (Barwell, 2016). The diversity issues described in this chapter stem from changes in schools and societies resulting from new migration patterns and outcomes. We use the original concept of superdiversity rather than intersectionality since the former refers specifically to migration-related categories whereas the latter focuses on the complex relationship between race, gender, class and sexuality (Vertovec 2017). Table 5.1 presents some data on linguistic diversity in science classrooms of six different countries in relation to official languages, students' nationalities, language education policy, language use in science classrooms, and science teacher preparation in multicultural and multilingual science teaching. This table shows examples of how science classroom diversity worldwide calls for science education researchers to undertake research on superdiverse science classrooms. Theoretical frameworks and research methodologies that are more culturally and linguistically relevant are needed.

5.3 Cultural and Linguistic Diversity in Science Education Research Publications

Expanding the representation of cultural and linguistic diversity in our research publications that also reflects the diversity of students in schools, scholars in academia, and research topics in science education is an issue of critical importance that has often been overlooked. Examining current trends in publications in science education journals can enable the science education research community to better appreciate to what extent research describing multicultural and multilingual contexts is being shared (Martin & Siry, 2011; Martin & Chu, 2015; Martin, 2020). To address this need, 2177 papers published between 2011 and 2018 in four top-ranked science education research journals were analysed to identify how many of these papers included one or more words from a list of more than 100 indicators that

Table 5.1 Linguistic diversity in science classrooms across the globe

	South Africa	United States of America	Lebanon	Catalonia, Spain	Republic of Korea	Chile
Official languages in the country	Eleven official languages: English, Afrikaans, and nine African languages	No official language at the federal level. Thirty-one states have made English the official language. Hawaii, South Dakota, and Alaska have other official languages	One official language: Arabic	Three official languages: Catalan, Spanish, and Aranese	Korean	No official language, though Spanish is the most common. Six indigenous languages
Students' national origins*	99.5% south African (76.4% black, 9.1% white, 8.9% Coloured, 2.5% Asian); 0.5% other	86.3% USA, 2.4% Mexico, 2.2% Middle East, 2.1% Central America, 1.7% Africa, 5.2% other (2018)	85% Lebanese, 9% Syrian, 4.6% Palestinian, 1.4% other	88% Spanish, 4% Morocco, 2.6% Latin America (19 countries), 5.4% other (2017)	~98% Korean, ~2% bi-ethnic (Korean + other ethnicity and non-Koreans)	97.8% Chileans, 2.2% Latin American countries (7 countries)
Language education policy	Since 1997 schools can choose any of the 11 languages as a language of instruction.	No national plurilingual or even bilingual education policy. Some school districts offer bilingual education, depending on state policies, parent advocacy, and critical mass of students	According to the 1989 constitutional amendments, schools are free to choose the language of science and math instruction.	Immersion schooling in Catalan was established in 1983. Since 2018 there has been a plurilingual education policy overcoming bilingualism.	The 2012, Bilingual Education Act established training for 125 teachers to provide limited bilingual language support.	Language education policy as part of a national intercultural education policy to revitalize the cultures of indigenous communities

(continued)

Table 5.1 (continued)

	South Africa	United States of America	Lebanon	Catalonia, Spain	Republic of Korea	Chile
Language use in science classrooms	In spite of policy provisions for use of any and all 11 languages in the classroom, English is the preferred language of instruction even for non-English speakers.	English is the predominant language of instruction. Some schools may offer bilingual support in other languages (mainly Spanish), but it varies by state/school district.	Arabic is first language. English or French is the language of science and math. Armenian and Aramaic are taught in some schools.	Catalan is the language of instruction. Science is taught either in Catalan or in a foreign language such as English in CLIL programs.	Only Korean language is used in classrooms. Some schools and classrooms provide sheltered Korean language instruction.	Spanish is the language of instruction. Few schools teach in Mapudungun or Rapanui.
Science teacher preparation on MC & ML Ed.	No specific training but some institutions have introduced courses/modules on language in science	Most programs only offer one multicultural education class to meet teacher certification standards.	Most programs do not explicitly address multilingual and multicultural issues.	Science teachers do not have specific training other than one general multicultural education class.	Science teachers do not have any specific training.	No national programs for science teachers but small projects in Auracania region

[a]Due to space limitations, national ethnic diversity is not reflected in this table although it is important for the description of students' diversity in science classrooms

Table 5.2 Journal publications related to multicultural or multilingual research

Journal	Total number of publications (2011–2018)	Total number of publications related to equity issues	Percentage related to linguistic diversity
JRST	416	71 (17%)	15 (3.6%)
Sci Edu	351	41 (11.7%)	11 (3.1%)
RISE	393	23 (5.9%)	10 (2.5%)
IJSE	957	77 (8.1%)	18 (1.9%)
TOTAL	2117	212 (10.0%)	36 (2.8%)

could appear as part of the title, abstract, or keywords (Martin, 2019). These indicators represented a wide range of topics focused on race, ethnicity, socioeconomics, language, gender, and religion and indicators related to concepts related to equity including ability, diversity, inclusion, and more. Two hundred and twelve papers were identified, representing a small total percentage of all papers published (10%). However, by focusing more narrowly on identifying what percentage of all papers related to equity and diversity issues addressed the topic of linguistic diversity in science education, the analysis revealed that less than 3% of all publications dealt with this topic (See Table 5.2).

To understand why so few science education papers that deal with issues related to linguistic diversity specifically have been published in these journals over nearly a decade, it is important to consider what kinds of structures may limit the scope of research and opportunities for research that deals with policy and collaboration, including lack of government policies requiring teacher education programs, professional development, curriculum, and material resource development to focus attention on equity issues (as reflected in Table 5.1). Without policy to support and inform decision making, it may be difficult to get the funding needed to engage in research on these topics. Additionally, most science education researchers may lack expertise in multicultural and multilingual research as the theories and methods underpinning these types of inquiry are not generally supported by traditional science education research trajectories. It could also be difficult to find outlets for publishing research focused on equity. Similarly, it can be difficult to find the right balance between the "science" and equity issues being addressed. In the past, some journals were less receptive to studies focusing on non-content-related topics; however, this analysis of journal publications has shown an increase in the percentage of equity-related publications since 2015, with at least one special issue in a journal dedicated to linguistic diversity in 2019 (see *Research in Science Education*, 49(4) and another in 2020 (see *International Journal of Science Education*, 42(14)) highlighting the complexities of multilingual contexts in science education (Salloum et al., 2020). While these developments are a positive step in the right direction, few structures currently exist to support collaborative efforts and networks for researchers to more directly address equity and language issues in their research. There is only one organization, which was established 3 years ago, focused on equity and social justice in science education research: *Science Educators for Equity, Diversity and Social Justice* (SEEDS; seedsweb.org). Finally, researchers in science

education lack professional organizations that can support the development of partnerships with equity and diversity scholars in other fields (language, sociology, anthropology, etc.).

5.4 Towards More Culturally and Linguistically Relevant Science Education Research

We advocate that science education research should be more culturally and linguistically relevant to be able to deal with the compexities of our superdiverse science classrooms. By *relevant* science education research we mean research that focuses on science curriculum and pedagogy connected to students' everyday lives and real local/global issues. It also integrates students' cultural and linguistic diversity, ways of knowing, and needs into the curriculum and pedagogy. This approach aligns with Aronson and Laughter's (2016) synthesis by embracing under the term "relevant" a group of approaches to multicultural education. What follows is a discussion of three aspects of relevant science education research that need change: (a) research methodologies and methods, (b) research networks and collaborations, and (c) education and research policies. We briefly present each aspect and provide some questions to activate reflection.

5.5 Rethinking our Science Education Research Methodologies and Methods

What research methodologies and methods could then enable us to best "see" and understand the lived experiences of the Other—the people whose culture, language(s), and socioeconomic status may be so different from our own? Based on our experiences doing research on equity, diversity, and social justice with marginalized populations we share some insights herein. These insights are articulated in more detail in recent publications (Rodriguez & Morrison, 2019; Tolbert et al., 2018; Rodriguez, 2016) and can be useful to frame the reflection on how to develop more culturally and linguistically relevant science education research. To address the question posed above, we suggest that all research methodologies and methods are appropriate for conducting research in culturally diverse educational contexts. Research methods (tools) and methodologies (research frameworks) are only necessary to organize schema for individuals to conduct research. Just like a carpenter chooses a hammer to hit a nail instead of a screwdriver, so it is up to the researcher to employ the right tools to investigate the desired research questions.

What we need to rethink then is how our *worldviews* and *positionalities* influence all aspects of our research work. That is, what research questions we choose to pursue, with whom and in which context we choose to collaborate, with which populations we choose to conduct our work, and why we choose certain topics and not others. To start this important reflexive process, we can ask ourselves two basic questions: For whom

do we conduct research? and Whose interests are being represented in our work? As mentioned earlier, we provide more comprehensive discussions of these questions elsewhere. Due to space limitations, we briefly provide below some practical suggestions for alternative ways of thinking about and conducting research in collaboration with the Other. The three aspects of culturally relevant research—caring, relevance and rigor, and relational responsibility—are meant to be enacted throughout the entire research enterprise and they are closely linked to one another.

5.5.1 Caring

Our knowledge of how sociocultural, historical, and institutional factors influence the participation and success of traditionally underrepresented students in science has increased significantly over the decades. We now know a great deal about how some groups are consistently marginalized due to their socioeconomic status, abilities in dominant language(s), family structure, ethnicity, skin color, gender expression and/or sexual orientation, and physical ability. We also know that good intentions and well-intended neo-liberal policies focused on "tolerance," "acceptance" and "diversity" have failed due to the recalcitrant disinclination to address the root causes of oppression. No one can dismantle these complex webs of oppression on their own, but we can more effectively contribute to this goal by embracing a *research ethics of caring*. This approach involves re-conceptualizing our research methodology and methods so that they provide multiple spaces for mutually beneficial collaboration and social transformation. In other words, deficit perceptions of the Other as "lacking" and "in need of saving" are substituted by respectful understanding of the Other as partners with unique voices and agency in the research enterprise. In this way, the focus shifts from seeking to investigate the Other so that they can be moulded into existing oppressive and dominant practices to working with the Other to expose and to transform those practices.

To help us reorient our thinking using a research ethics of caring, we can ask ourselves these questions: Who/what do we care about when conducting science education research? Why do we conduct research on a chosen topic? Is it to advance research and practice, benefit educators and their students, increase scientific literacy, advance knowledge in our field, or secure our own academic advancement at our institutions. Should any one of these answers matter the most, and if so, who or what is most negatively compromised by that answer?

5.5.2 Relevance and Rigor

To begin the shift to a research ethics of caring, we need to recognize that traditional, masculine, Western notions of "objectivity," "rigor," and dichotomous framings are forms of colonized thinking that only serve existing power structures.

Instead, if we focus on *relevance*—how our research is relevant to the needs of the individuals collaborating with us—then *rigor* takes on a different meaning. That is, rigor becomes a construct in service of the people involved in our research and not a construct in service of a presumed detached, objective community of researchers: a community that too often pretends to exist outside of the very same world in which it conducts its research.

These questions could help us begin to make relevance our primary focus: In what ways is our science education research contextualized and responsive to the participants' needs? In what ways are participants involved as collaborators (voice and agency)? In what ways are our claims (impact/research findings) measured by the benefits in the lives of the people involved in our research from their point of view?

5.5.3 Relational Responsibility

None of the suggestions shared thus far are possible without first recognizing our positionalities as privileged intellectuals. As middle-class science educators and researchers, we hold unique positions of power that by default give us the *responsibility* to establish a more *relational* and mutually beneficial collaboration with the Other. Thus, instead of seeking to suppress our humanity through colonial and detached notions of "objectivity" and "rigor," we should seek to embrace the humanity represented in a research ethics of caring. In this way, we position ourselves not as the only purveyors of knowledge, but as members of multiple communities that influence, and are influenced by, the people and the sociocultural context in which we work.

When we consider these questions, we can appreciate the importance of relational responsibility: When we begin a research project, in what ways are we seeking to establish meaningful, respectful, and mutually beneficial collaborations with the participants? What are the benefits from the participants' points of view? In what ways are we reflecting and acting on our privileged positionalities so that we do not just hear but *truly listen* to the participants' voices and understand their experiences? In what ways do we recognize and act upon how we may be implicated and benefit from the very webs of oppression that we write about in our research?

5.6 Reorienting our International Research Networks and Collaborations

A more culturally and linguistically relevant science education research demands that researchers reorient their ways to collaborate at both the national and international levels. Current trends in globalisation make collaboration in science

education research imperative to understanding both local and global issues in the teaching and learning of science and identifying relevant, common, and specific solutions. Thinking about other researchers' contexts may also help us to think differently about our own contexts and blind spots. During this current time of dwindling research funding, collaborative research could also provide a means to mobilise multiple expertise to improve funding success. The potential areas for collaboration arise from the very variability that a global rather than local gaze brings.

5.6.1 The Research Focuses of Collaboration for Language Diversity

Science teaching and learning in multilingual classrooms happens within a universal political context in which access to the dominant language provides access to the culture of power. We need research that confronts predominant discourses that do not acknowledge the *value of multilingualism* and that frame multilingualism not as a deficiency but as something positive, and even preferable to monolingualism.

We need to expand our understanding of the *dynamics of language* as a resource and not a barrier in science teaching and learning. Some ideological and epistemic considerations include challenging discourses of deficiency of non-dominant languages that undervalue the currency of non-dominant languages in science learning. We need to challenge the use of the dominant language as a measure of ability in science learning. Collaborative research can help by augmenting empirical evidence from a diversity of contexts to demonstrate how science can be learned in any language.

Our collaborations must address ways in which *pedagogical use of language* in the science classroom can include rather than exclude learners, invariably those from low socioeconomic backgrounds. Collaborations have potential to critique diverse and discordant language policies and curricula across the global social, economic, political, and linguistic contexts elaborated in this chapter. Developing collaborative relationships that can lead to transformation in policy and practice will require structures to ensure equitable participation.

5.6.2 The Challenges of Collaboration

The need for careful management of intra-national collaboration in geographical, economic, and policy contexts that are nearly homogenous cannot be taken for granted. This need becomes greater in inter-national or cross-national collaborations, even within the same socio-political and economic zones where there are many variable contexts. Policy contexts, however, are lagging behind. Partner countries' policy frameworks are an important affordance for dealing with language

issues in teaching and learning. Critiques and comparisons cannot be made without careful consideration of the diversity of legal and educational contexts that inform and are shaped by the diversity of policy frameworks. This calls for research collaborations that are fair and ethical so that their findings have the integrity to be relevant locally and globally. In addition to the variation in education and language policy across nations, there is the matter of variable funding policies and requirements by funders.

5.6.3 The Tensions in Collaboration

The tensions in the quest for inclusion in collaborative research manifest in diverse ways. For instance, the inclusion—or largely the exclusion—of scholars in certain racial, ethnic, or socio-economic categories in collaborations and/or publications is particularly interesting in the way it plays out both in similar and different ways in different contexts across the globe. In Africa, for instance, policy developments in individual African countries and the external policies governing the funding often masquerade as inclusive of academics in African countries. Over the past few years, there has been an increase in interest by both the global North, the global West and the global East in collaborating with African scholars, particularly black academics and researchers (Department of Science and Technology, 2020). With a shift from research *on* Africans to research *with* Africans, inclusion of African scholars has become a more visible requirement in policy frameworks and nation-to-nation funding agreements. However, questions still abound on the ethics and relevance of the intended research and the nature of the collaborations so fostered: whether and how policies and funding calls, for instance, are structured in fair and ethical ways to meet real needs and goals of the "overseas" partner and/or their country; the power relations embedded in the fine print of funder's policies; whether and how overseas academics can exercise agency and negotiate themselves into the partnership for truly mutual benefit; how the conduct of the research on the ground respects, recognizes, and protects all participants while meeting the requirements of an international funder (usually faceless) and/or the collaborating partner. Meaningful collaborations must demonstrate genuine shifts from "extraction"' from research sites to equal, fair, and ethical sharing of the research in terms of agency and ownership of the research, decisions on data management and dissemination together with clear agreements on envisaged intellectual rights (Suresh, 2012).

Research funding practices and legal frameworks in global collaborations must include an explicit requirement for proper representation of marginalized groups in studies with a focus on marginalized populations. Token inclusion of equity and diversity discourse in proposals just to secure funding without any accountability clause by the funding agency can only lead to continued large expenditures without any of the anticipated impact on teacher preparation and/or student learning, particularly in poor communities. Research on the benefits of such funding continues

to show persistent lack of meaningful change in spite of substantial investment in education research (Heinze, 2008).

Meaningful cross- and inter-national collaborative research calls for respectful and mutually beneficial negotiations. To maximize the benefits of collaboration, we should consider the following questions: How do the benefits differ for collaborating partners? How can benefits be maximized for all partners? What terms and conditions need to be agreed to upfront in view of diversity of policy and economic contexts? What are other possible issues of concern that must be included in the various agreement documents?

5.7 Influencing Language Education Policies

A more culturally and linguistically relevant science education research demands that researchers get involved in the construction and implementation of educational policies as part of their research work. Language education policies need to be seen as dynamic processes in which all community members engage in active negotiations in order to replace more top-down approaches to policy research and practice (Menken & Garcia, 2010). From this perspective, influencing policy implies participation not only in the construction of the policy document but also in the interpretation, negotiation, and ultimately re-construction of the policy implementation process.

One of the ways to influence policies related to language learning and use and equitable access and success in education is by developing and actively pursuing strategies to make citizens aware of the changing nature of the demographic composition of societies. According to Pujolar (2007), globalization and increased mobility have altered the linguistic make-up of almost all contemporary societies. The changing demographics of many countries as a result of legal and illegal immigration or displacement of people because of war and natural disasters has resulted in many countries that were initially considered monolingual becoming multilingual countries. Bermingham and O'Rourke (2018) propose that "multilingualism has become the norm rather than the exception and more and more, individuals find themselves engaging in a language or languages other than their 'native' or 'national' one" (p. 143). However, the governments of many countries whose populations include relatively high percentages of immigrants from various ethnicities still maintain the primacy and purity of the dominant language (Golden, 2001), as reflected in Table 5.1. Consequently, parents of immigrant children and human rights groups support providing immigrants and refugees voice and agency to decide their own fates, including their rights to maintain their mother tongue because it is the carrier of the culture and a means to stay connected with their families who still reside in their homeland (Kwon, 2017).

Another way to influence language education policies is by reconceptualizing the role of language in the teaching and learning of different curriculum areas. In the context of learning science, language is viewed as a mediating artifact and cultural

tool in science and science classrooms. Karlsson et al. (2019) detailed the role of language in science education. It can either be a bridge that provides students with access to science or an obstacle that alienates students from the context within which scientists work and science develops. The role of language is even more prominent and multilayered in multilingual science education. This has resulted in a persistent concern in multilingual science education because of the pervasive achievement gap in science between language learners, who are typically immigrant children, and their counterparts (Ünsal et al., 2016).

In addition, several other endeavors can be used to have an impact on policy through science education research. Examples of these endeavors include conducting research that has an impact on practice, such as action research and design-based research; being involved with policymakers in setting research agendas; involving teacher education institutions in setting research agendas; conducting research on effective instructional methods geared towards teaching and learning in multilingual contexts, and communicating research findings to those who are interested in their practical implications, such as policymakers and teachers.

To empower science education research communities to be able to change language education policies to become more oriented towards equity and social justice we should consider the following questions for reflection: What implicit and explicit language education policies are in place? How are these policies preventing marginalized community students from access to educational resources and success in science education? How do science and science education researchers develop their agency in the implementation of language education policies in particular superdiverse contexts?

5.8 Conclusions

What steps could researchers take to undertake science education research that is more culturally and linguistically relevant? Starting with the most basic question of who benefits from our research can encourage us to begin a process of honest and transformative introspection that could lead to new research collaborations and opportunities for addressing equity, diversity, and social justice issues locally and globally. With these goals in mind, we have suggested that when conducting science education research in culturally and linguistically diverse contexts, we need to focus more on how our research benefits the participants. This involves listening more closely to their needs and exploring ways in which our research processes and findings can help address those needs. In this chapter we have identified three ways to conduct more culturally and linguistically relevant science education research, but some other equally important areas were not addressed. One of them is the development of design based-research to identify science teaching methods, materials, and additional learning opportunities that would benefit students' learning in multicultural and multilingual science education contexts. Another area deals with the provision of culturally and linguistically relevant science teacher professional

development, which at the moment is lacking in many countries. International associations such as ESERA[1] (Europe), EASE[2] (Asia), REDLAD[3] (Latin America), ASERA[4] (Australia), SAARMSTE[5] (Africa), and NARST[6] (USA) can play an important role in providing the support for the development of a most needed agenda on culturally and linguistically relevant science education research.

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[1] European Science Education Research Association (esera.org)

[2] East-Asian Association for Science Education (theease.org)

[3] Red Latinoamericana de Investigación en Didáctica de las Ciencias Experimentales

[4] Australasian Science Education Research Association (asera.org.au)

[5] Southern African Association for Research in Mathematics, Science and Technology Education (saarmste.org)

[6] National Association of Research in Science Teaching (narst.org)

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