

# Chapter 14

## Indigenous and Afro Knowledge in Science Education: Dialogues and Conflicts



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**Abstract** This chapter provides ethnographic descriptions and analyses of interviews with indigenous and Afro-Colombian (The term refers to the descendants of Africans who survived the slave trade and to their dual affiliation: to both their black African roots and the Colombian nation. In some articles, especially those from Africa, the original African cultures are called “indigenous” (Semali and Kincheloe (Eds), *What is indigenous knowledge? Voices from the academy*. New York and London: Falmer Press, 1999). However, in America they are called “Afro” in order to distinguish them from the original American cultures.) teachers and of some discursive interactions with their students in primary school classrooms in underserved communities. In those contexts they mobilize their local community knowledge for science lessons. We analyzed the teachers’ purpose in incorporating indigenous and Afro knowledge in teaching science and how these different knowledge systems work in the interaction. These teachers’ and students’ co-constructions modify and enhance the official science curriculum with forms of resistance to the scientific myth of only one universal truth about physical phenomena. This resistance is based on the strength of their collective identity constructs as well as their connection with and respect toward nature. These kinds of studies are relevant references for a culturally sensitive science curriculum development.

### 14.1 Introduction

Historically, Western education in neoliberal countries reproduces Eurocentric (a form of ethnocentrism) science proposals as the only legitimate and true kind of knowledge about the physical world. Neoliberal countries tend to homogenize educational policies that, aside from propping up the interests of the global market

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(Valenzuela 2003), encourage a relationship of control and exploitation of nature. However, if we understand that knowledge is situated as a product of activity in a cultural context (Lave 2011), we have to accept that different systems of knowledge are developed from the cultural diversity of the schooling participant (Colbern and Aikenhead 2003; Barnhardt and Kawagley 2005; McKinley 2007).

In the face of these trends, we are interested in studying whether teachers, especially from indigenous and Afro backgrounds, resist educational proposals that do not take into consideration the students' and communities' cultural worldviews.

In this paper we assume that any sociocultural configuration, such as school, is a product of a variety of global, national, regional, and local traditions that are interrelated in ways that on the one hand reproduce the neoliberal system but on the other construct spaces where alternative practices and knowledge are cultivated, inasmuch as these traditions have differing degrees of relative autonomy with respect to global proposals (Rockwell 2009). It must be recognized, however, that the different traditions have both similarities and differences, which can lead to internal contradictions when it comes to day-to-day teaching practice. These contradictions produce developments, changes, and transformations in this practice, a dialectical relationship of reproduction/resistance in response to the proposals of the dominant system. In multicultural countries of Latin America, such as Mexico and Colombia,<sup>1</sup> some of these traditions and influences are imposed by the power of the national system, but others have their roots in alternative historical contexts situated in local networks, in oral traditions, and even in pre-Hispanic heritage (Rockwell 2009), primarily in indigenous and Afro-descendent communities that preserve representative features of their ancestral culture (Bonfil 1990).

As certain ethnographic studies show, teachers and students come to the classroom with knowledge and practices from the local culture, thus constructing a diversity of everyday school cultures (Rockwell 1997). In line with these findings, Nespore (1994) contends that classrooms have permeable walls that allow for communication with other spaces and times, specifically the culture of the community where the schools are located.

This article seeks to analyze empirical data from classroom interviews and interactions in order to find out how science is taught in schools situated in indigenous contexts in Mexico and in Afro-descendent contexts in Colombia. We conducted ethnographic research to see whether different knowledge systems coexist in these educational contexts and to understand how these divergent systems are managed in everyday teaching practice. The aim is to describe the relationship between the knowledge systems rooted in Western science and promoted by national

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<sup>1</sup>In Mexico, more than 68 ethnic groups (8% of the whole population) keep their culture alive through their language and traditions. Colombia also has a rich ethnic diversity with 94 indigenous groups maintaining 64 different languages. 3.4% of the Colombian population is indigenous and 10.6% is Afro-Colombian. These groups are marginalized and tend to live in the worst economic and social conditions within the neoliberal system of the region, with underserved schools as a consequence (Walsh 2007).

study plans and the alternative knowledge systems based on different cultural referents that teachers and students from indigenous and Afro-descendent cultures bring to classroom interaction.

The importance of an ethnographic study such as this one lies in the potential to provide information from the perspective of educational actors, in order to provide information to attend the growing demand of different ethnic groups around the world for a democratic education that takes its knowledge into account, especially as it bears on their relationship with the natural world. Most of the movements undertaken by the 50 million indigenous inhabitants of Latin America, such as the Zapatista movement, call for and try to develop an education that respects their identity-affirming conceptions and their vision of nature (López 2001). Of particular interest is determining whether participants bring to science classrooms their ancestral ethnic group's relationship with nature, which over millennia has proven its ability to maintain sustainable development that ensures the survival of both humans and other species. As Barnhardt and Kawagley (2005) argue, the ancestral knowledge of original groups can benefit all students as it upholds values, beliefs, and practices that are increasingly being recognized as legitimate and relevant for today's world.

It must also be taken into account that globalization generates a growing inequality that leads to the migration of large human groups, who have to leave their cultural context of origin. This situation contributes to a great presence of multicultural classrooms in schools of most countries all around the world, many of them in need of intercultural education (IE) in order for their students to better understand and learn. Even though a significant number of intercultural proposals have been made around the world, especially in non-developed countries, there are less studies that analyze empirical data of the procedures that teachers and students from indigenous and Afro communities use in including their local knowledge in science education. There are also few articles that study the indigenous or Afro knowledge topics that are spontaneously included in those classroom contexts and the teachers' motivations to do it.

Understanding the dialogues, conflicts, and constructions between indigenous and scientific systems of knowledge in classroom interaction (Bang and Marin 2015) and how educational participants deal with them can contribute to further intercultural proposals for science education as a task in construction (Godenzzi 1996) that can challenge the Eurocentric, positivist perspectives of science education.

In this sense, this article analyzes voices (Bakhtin 1981) from teachers and students in indigenous and Afro-Colombian communities who incorporate local interpretations of the natural environment into their classroom interaction, despite operating educationally within national Eurocentric science programs that do not consider alternative conceptions of nature.

This paper's results show teachers from indigenous and Afro-Colombian backgrounds manifesting ethical responsibilities to nurture scientific knowledge with the cultural perspective of their original communities, particularly about nature. They all challenge the irrational exploitation of nature that Western scientific anthropocentric

approaches promote by mobilizing their spiritual and holistic relationship with the natural world in their classrooms. This can be seen as a form of resistance against scientific knowledge as the sole and universal truth. The empirical data of this paper bring to light the tensions between the production of scientific and indigenous knowledge in these communities, as challenges to the cultural reproduction of Western scientific perspectives. These results bring into debate what kind of voices and knowledge production these educational actors can reconcile and what others prove to be resistant to negotiation. The paper offers empirical examples of what educational practices must take into account when working with diverse cultural knowledge constructions without denying or jeopardizing any of them.

In order to develop the argument of the paper, we describe academic research that studies the problems of dialogue between scientific knowledge and other cultural knowledge constructions (Godenzzi 1996). We also present some theoretical advances of science education orientations that discuss the possible coexistence in the same person, organization, or community of divergent systems of knowledge about the physical world (Barnhardt and Kawagley 2005). We describe features of the fieldwork and methodological approaches to analyze the collected empirical data and arrive at some final thoughts.

## 14.2 Indigenous and Scientific Knowledge

Aikenhead and Owaga (2007) review the origin and features of scientific knowledge and of indigenous systems of knowledge in order to explain similarities and differences between those systems of knowledge that allow for building some bridges between them. These authors show that both systems are culture-dependent and that neither is superior to the other, only more pertinent depending on the context. They both exhibit rational thinking, are predictive, use empirical approaches, and are continually being revised in the light of new observations and the contributions of other conceptions. However, they also have relevant differences. Indigenous knowledge tries to be harmonious with nature, while science sets out to dominate it. Indigenous knowledge is monistic because it does not separate matter and mind and sees everything in the universe as alive: animals, plants, humans, rocks, celestial bodies, natural forces, etc. (Cajete 2000). In indigenous knowledge, inner space (the spiritual world) and outer space (the physical world) interact holistically (Ermine 1995). In Eurocentric science, on the other hand, Cartesian dualism separates mind and matter, and the connection to nature tends to be “reduced to a relationship of material production” (De Sousa 2015: 15).

However, these different knowledge systems are constantly adapting and changing in response to new conditions and in relation to their interactions (Barnhardt and Kawagley 2005). Even Western science incorporated knowledge from different cultures such as Chinese, Arabian, and Mesoamerican.

In the literature there is a debate regarding how to relate this conceptual and epistemological diversity for science education proposals. Pomeroy (1992)

summarizes this debate by postulating nine research agendas for teaching science among different cultural systems; these agendas can be grouped into two different perspectives: (1) assimilationist, all those proposals that take into account indigenous themes, explanations, and/or languages in order to include them in a scientific approach by trying to explain them from a scientific perspective, emphasizing Western science's power to explain and predict, and (2) anthropological or autonomous enculturation proposals, those that compare and build bridges and analyze epistemological conceptions and explanations of the physical world contributed by Western science as well as everyday and other cultural systems of knowledge, with no attempt to subordinate or eliminate any of them.

June George (1999) provides interesting ideas for using indigenous knowledge as a component of school science curriculum, developed from his work in Trinidad and Tobago. He constructs four categories in order to build bridges between science and indigenous knowledge: Category 1. Indigenous knowledge can be explained in conventional science terms. Category 2. A conventional science explanation for indigenous knowledge seems likely but is not yet available. Category 3. A conventional science link can be established with the indigenous knowledge, but the underlying principles are different. Category 4. Indigenous knowledge cannot be explained in conventional scientific terms.

George suggests the use of indigenous knowledge from category 1 in science classes in order to highlight similarities between the two systems, generate interest among the students, and develop pride in the knowledge and wisdom of their ancestors. Knowledge from category 3 can also be a good point of departure to explore and discuss their resemblance. For George category 2 is a fertile area for scientific research; however, constructing relations between the two systems of knowledge is frequently beyond the students' capabilities. I think this kind of knowledge can develop identity values and pride for indigenous students as well as respect and some interesting ideas for other students to learn. Knowledge from category 4 represents the biggest challenge for the teachers. For this last kind of knowledge, he suggests exposing the students to both knowledge systems to illustrate that in the conduct of our lives, we sometimes draw on different knowledge systems. This last idea seems to take into account the possibility of addressing diverse knowledge systems in order to use them in different contexts.

Aikenhead and Owaga (2007) propose recovering and continuing George's initial work in order to classify more topics of indigenous knowledge and to study how they can be used in science classes. However, they take note of the epistemological differences that must not be overlooked. For example, they describe that in holistic indigenous thought (which does not separate mind and matter), a herbal cure cannot achieve the same effect without the ceremony and ritual songs, chants, prayers, and relationships they used to have in the original context (Battiste and Henderson 2000: 43), even though it can also be explained in scientific terms.

For Bang and Marin (2015), science education that takes into account indigenous systems of knowledge improves the quality of learning and opens opportunities for students from historically non-dominant communities. Building these science learning environments expands the boundaries of reality and possible futures for students.

### 14.3 Science Education Approaches

The proposals for science education have been changing as a result of theoretical and epistemological developments since the 1960s.

Recent advances in educational research come from connections among different fields and research traditions such as psychology, sociology, anthropology, and the research results of studies of language in sociolinguistics, linguistic anthropology, and diverse discourse analyses. An important task is to articulate related fields and confront and complement diverse disciplinary traditions and approaches in order to understand classroom dynamics where formal education takes place. In order to capture the complex processes occurring in classrooms, research must necessarily be interdisciplinary (Candela et al. 2004).

Some philosophical and sociological approaches help to redefine the epistemological status of science as a cultural construction (Elkana 1982) that cannot sustain its superiority over other cultural systems of knowledge, only its more pertinent explanation in some contexts.

One of the most influential models based on the Piagetian psychogenetic perspective was the conceptual change model (Posner et al. 1982) that develops some procedures in order to generate a cognitive conflict with “misconceptions” (ideas that differ from scientific postulates) in order to eliminate them and construct scientific concepts. This model is based on the idea that scientific concepts are incompatible with “common sense” or other cultural ideas.

Challenging the model proposed by Posner et al. (1982) of changing everyday ideas for scientific ones, two decades of research have shown that students, even from university level and after several science courses, can still have “common sense” ideas about some scientific topics. The responsibility for this problem has frequently been attributed to pedagogical deficiencies or to teachers’ incompetence. Efforts to improve teaching models have not had significant results in eliminating “common sense” and other cultural ideas.

To deal with this problem, one recent and productive line of research in science education confirms that everyday ideas can coexist with scientific conceptions (Scott 1987). Relevant contributions in this sense have been made by Mortimer (1995), who questioned the ontological and epistemological backgrounds of the conceptual change model because it is based in the empiricist idea that people have a single conceptualization coming from a direct perception of the natural world. Mortimer states that everyday ideas do not disappear when a person appropriates other notions about the same topic.

Today science education perspectives recognize that several cultural, common sense, and scientific ideas can coexist, even in adults with an academic education, as they are useful in some contexts. This is what happens with religious and magical ideas that even well-known physicists maintain for everyday, psychological, or emotional needs. It is also important to take into account that these different conceptions are not necessarily coherent with each other and can be held without generating personal conflicts (Hodson 1999).

Taking into account the possible coexistence of different cultural systems of interpretation of the physical world, advanced developments of science teaching

(Mortimer 1995) propose helping students develop the ability to analyze different conceptions of the world and to make decisions on the basis of the most pertinent perspective and explanation in each concrete situation.

Another important influence of psychology on science education came from the sociocultural approaches grounded in Vygotskian ideas (1984). For Vygotsky knowledge construction was based not only on individual relationships with natural endeavors, as the Piagetian perspective states, but also on the cultural and historical conceptions interiorized from social interaction in order to interpret the natural environment. These developments contribute to understanding why students from different cultural backgrounds can have divergent interpretations of the physical world.

## 14.4 Fieldwork and Empirical References

This is a qualitative (ethnographic) research paper that sets out to analyze the meaning of teaching ideas for educational actors (Erickson 1986). In the analysis of the interviews and the excerpts of interaction in the classrooms, we understand that educational actors do not only interact “face to face” among themselves. We assume they interact simultaneously with people, cultural artifacts, and diverse representations that they mobilize from distant spaces and times (Nespor 1994).

The paper provides sociocultural analysis of fieldwork notes and audio recordings of semi-structured interviews with a Mexican indigenous (Tere) and an Afro-Colombian (Stella) science teacher in the context of a Western science curriculum for their underserved primary schools in indigenous and Afro-Colombian communities. Other data came from five semi-structured interviews about the experience of a physics teacher (Juan) after 2 years of teaching in an intercultural program at an indigenous high school (Candela 2013). We also analyze some extracts of 3 audio recordings of Tere (with 19 children from combined first- and second-grade classroom) and 48 audio videos of Stella’s science lessons (fifth grade) that open up alternative spaces by mobilizing ancestral knowledge from their communities.

We became familiar with these contexts in relatively time-extended stays for the purpose of building specific knowledge through the documentation of participants’ discourse and practice. We presented ourselves to the teachers as researchers interested in analyzing how they teach science in the context of indigenous and Afro-Colombian communities.

Tere was born in an indigenous Purépecha community of the Mexican state of Michoacan. She studied an undergraduate degree in Pedagogy and two master’s degrees—one in Learning Difficulties and the other in Psychogenetics. She has 29 years of teaching experience in one-room elementary schools (teaching six grades simultaneously) in indigenous communities, as well as at graded monolingual schools, both Purépecha- and Spanish-speaking. She was working at a K-6 school in Ichupio, a community on the banks of Lake Pátzcuaro in Michoacan. Ichupio has approximately 350 inhabitants, most of them Purépecha-speaking, who earn their living by fishing and by producing and selling agricultural and handcrafted products,

activities that generally bring in little income. This teacher has been working with some other indigenous teachers in the construction of culturally sensitive teaching proposals for their region. The neoliberal national educational program imposed by the Mexican government does not recognize this kind of experience, however, and they cannot control everyday practices at the schools.

Stella is a Colombian teacher who was born in Cali and identifies herself as *Afro-Colombian*. She has undergraduate degrees in Biology and Chemistry; a master's degree and specialization in Ecology, Environment, and Development; and experience in Afro ethnoeducation and the teaching of Afro-Colombian studies. She has over 30 years of teaching experience, both in public and private schools and at the kindergarten, elementary, middle, and high school levels, in both urban and rural contexts. She works at a school in southeastern Bogota, a district known for low-income levels and precarious living conditions. Many families are immigrant or displaced who have come to the city looking for job opportunities and decent living conditions; job opportunities, however, are scarce. The ethnographical data were collected in a group of 41 fifth and sixth graders during several prolonged stays over a period of 2 years and 3 months. Forty-eight classroom video recordings were made as well as three audio interviews with this teacher.

The indigenous teacher interviewed in the Tzeltal community of Chilón, in the Mexican state of Chiapas—called Juan for confidential reasons—studied physics for 4 years at a local university in Chiapas. He has 15 years of experience teaching this discipline at the high school level in Tzeltal communities. He shares the culture and language of his 20 Tzeltal students. The Tzeltals are one of the indigenous groups that still have their own language and culture in Chiapas. Chilón has 395 inhabitants, 84 of whom are monolingual in the Tzeltal language and the rest speak Tzeltal and Spanish. Almost the entire population works in the agricultural sector and has a low socioeconomic level. We have ethnographic notes from Chilón, where we stayed for 2 weeks, and five interviews with Juan at the school.

After transcribing all the interviews and classroom recordings, and reading them a number of times, we selected discursive excerpts from the three contexts in which we found relevant information about the relationship between indigenous or Afro-Colombian and scientific systems of knowledge. In the following section, we analyze the arguments the teachers provide for including local knowledge in their science lessons. Further sections present analysis of the way they deal with both systems of knowledge in classroom interaction. These excerpts were analyzed in an attempt to understand the significance of the natural world that the participants construct within their local knowledge and the scientific worldview.

## 14.5 Self-Recognition of Their Own Culture

In this section we analyze excerpts of interviews with the teachers from the three contexts (Tzeltal and Purépecha communities of Mexico and one Afro-Colombian community), in which they advance some arguments about why they consider local knowledge when teaching science and how they do it.



In the following discursive sequence, Juan not only confirms that he mobilizes Tzeltal cultural knowledge in the physics lessons, but he also explains to us why it is important to do so.

**Juan:** We have to know about our history, our culture. . . our elders, so that we know what we have and appreciate who we are . . . it's a matter of raising awareness, of acting conscientiously, so that we recognize and don't forget that we have knowledge, not only knowledge but also values, and that these values can also be transmitted through the topics of these disciplines . . . but we don't have to accept everything from scientific culture . . . there are things that make life easier but also things that affect us....

**Juan:** Tenemos que conocer sobre nuestra historia, nuestra cultura, de nuestros mayores, para conocer lo que tenemos, y valorar quiénes somos . . . es un asunto de concientización, de actuar con conciencia para reconocer y no olvidar que nosotros tenemos conocimiento, pero no sólo conocimiento sino valores y que esos valores también se pueden transmitir a través de los temas de estas disciplinas . . . tampoco tenemos que aceptar todo lo de la cultura científica . . . hay cosas que nos facilitan pero también hay cosas que nos afectan . . .

The first argument this teacher provides to justify incorporating his indigenous knowledge in science lessons is about the importance of preserving his indigenous culture as “acting conscientiously,” raising awareness in the students about their culture and their responsibility and ethical position with regard to it. He mentions that they, referring to himself and the members of his ethnic group, must not “forget” and need to appreciate what they have and who they are. In his proud declaration of his Tzeltal identity, he also takes their history and culture through the elders’ voices as a source of knowledge.

He mentions, as an implicit form of conflict with science, that they have not only knowledge but also values, a holistic conceptualization that we usually do not see in science. He points out that values come from their traditional culture. However, trying to avoid a confrontational position and constructing bridges with science, he mentions that these values can also be introduced into science lessons. It can be said that Juan revisits scientific knowledge from the perspective of the Tzeltal culture in order to incorporate some values into science. This is what Colbern and Aikenhead (2003) called “autonomous enculturation.”

He adds that not everything proposed by science should be accepted. This implies that his adherence to the “mother” culture is apparently unconditional, while science’s contributions are conditioned by their impact on daily community life (there are things that affect us). It is interesting to note that he uses social criteria to accept some scientific formulations, and not only their relation to empirical evidence. This orientation shows some of the collective criteria that dominate in indigenous communities, as opposed to the individualistic ideology of the Western world.

In what seems to be a similar commitment with her culture, Stella talks in an interview about the recognition and visibility of Afro-Colombian culture:

**Stella:** (. . .) part of the problem is that I, as a human being, was taught that I am above everything else, that I take something and exploit it and overexploit it, until it's all used up. We believe we are superior, or in other words, we have an anthropocentric worldview. But I depend on nature. In other cultures, relationships are not pyramidal; they are about communion. So I tell the kids: in terms of culture, there's indigenous, there's Romani, and there's Afro; we're going to work with Afro because it's the culture with the least presence in

schools. It is also the way to think how I can build a broader identity, less burdened with the idea that is often taught to children: “Don’t mess with him because he’s black.”

**Stella:** (...) parte de problema es que se nos ha enseñado que yo, ser humano, estoy por encima, que cojo esto, lo exploto y sobre-exploto y lo acabo. Creemos que somos superiores, es decir, tenemos una visión antropocéntrica del mundo. Pero yo dependo de la naturaleza. Hay otras culturas que su relación no es piramidal, que su relación es en comunión. Entonces yo le digo a los pelados (*los niños*) : está la indígena, está la romani y la afro; vamos a trabajar la afro porque esta cultura es la que menos entra a la escuela. Es también la vía de pensar cómo construyo una identidad mucho mas amplia y menos cargada de eso que suele decirse a los niños, “no te metas con ese porque es negrito.”

In this intervention, Stella also states as one of her responsibilities the mobilization of her and her students’ Afro-Colombian culture in the classroom. However, she grounds her decision in the importance of questioning the anthropocentric vision of education that assumes human superiority that justifies the exploitation of nature, thus challenging the being/doing/knowing epistemological configuration as defined by the episteme of Western modernity.

She builds for herself and her students a “broader identity” that includes Afro and other indigenous and Romani cultural elements in order to construct a non-racist identity avoiding discrimination against Afro descendants themselves. (“Don’t mess with him because he’s black.”) Stella supports her decision to teach about the Afro culture with the argument that it is the most discriminated culture at school among other minority groups such as the Romani. With her discourse she constructs the purpose of avoiding cultural discrimination as one of the educational goals of her practice. She also talks about mobilizing ancestral epistemological alternatives, for the purpose of configuring a body of knowledge grounded in communion with nature.

In an open interview with Tere, in which she is asked how she teaches science in her community, she said that she is aware of the importance of mobilizing her Purépecha culture regarding the relationship with nature, in the classroom.

**Tere:** We try to show children how science and technology are exhausting our natural resources, exploiting them irrationally. (...) we have to consider how our ancestors thought and that is our greatest responsibility. It is up to us teachers to preserve our Purépecha culture... we have to rescue and strengthen certain customs....

**Tere:** Se busca mostrar a los niños cómo la ciencia y la tecnología vienen acabando con nuestros recursos naturales, explotándolos de manera irracional (...) hay también que pensar como pensaban nuestros antepasados y esa es la gran responsabilidad que se tiene. Es que en nosotros, los maestros, está la responsabilidad de que nuestra cultura, el purépecha, se siga sosteniendo y... hay que rescatar y fortalecer algunas costumbres....

She expresses a rejection of the irrational way science and technology have exploited natural resources but adds a reference to teachers’ responsibility to mobilize their ancestors’ views, to rescue and strengthen certain customs in order to keep Purépecha culture alive, and to prevent students from reproducing the irrational exploitation of nature. With her discourse, Tere is constructing a teaching role that consists of rescuing customs that seem to be fading away.

These examples show that one of the most important ideas these teachers put into consideration for teaching science to an indigenous or Afro community, even within

a national curriculum of Western science, is making the students aware of the respect that indigenous and Afro cultures show toward nature. They put this cultural knowledge and attitude in opposition to science and the technological depredation of natural resources. We can say that these teachers display culturally sensitive teaching in bringing the community's cultural knowledge and relationship with nature to science lessons because it tries to maintain harmony with nature, while science sets out to dominate it (Aikenhead and Owaga 2007).

Another important aspect to be noted is that, in these cases, the teachers' stance does not correspond to individual activism only but is supported by community decisions that are shared with them. For example, in Tere's case, she designs her educational projects considering the opinion of the community, which decides at an open assembly which problems need to be addressed in school. ("We start with community planning. . . that is jointly agreed upon at the parent-teacher meeting according to the issues faced.") Stella also has the full support of the community's adults ("Older adults became the leading actors in this community project, because they made it possible for this type of knowledge to circulate") to mobilize community knowledge and voices at school.

These examples show the teachers' commitment to maintaining their culture and the urgency they feel about passing on the values of their ancestral cultures to their students, particularly with regard to their respectful relationship with nature. These teachers also concur in terms of discussing in the classroom concerns that are not only their own but are also shared by the community as a collective commitment, an approach that is typical of communitarian cultures. This deeply held commitment would seem to be a first necessary characteristic for teachers to try to reconcile knowledge systems rooted in science with others that grow out of the communities' ancestral cultures. It could be that this commitment shared by all three teachers helps to explain the resistance that these cultures marshal in order to preserve their identity and inherited knowledge.

In the following section, we will look at how these different systems of knowledge of the natural world are presented and mobilized and how teachers and students wield them at school.

## 14.6 Alternative Knowledge Systems

In order to study the tensions among different knowledge systems of the natural worldview and how teachers deal with them, we analyze interview excerpts as well as classroom interactions.

After a question about how he manages to talk about local knowledge in his physics lessons, Juan answers the interviewer:

**Juan:** Hmmm, well, I related it to the seasons, regarding the position of the moon, the full moon, the young moon, as they say here (.2) we observe that there are things to which science says no, that is not correct; but here, from the point of view of our culture, that is how it happens, such as, for example . . . science says that you can plant at any time, but our

mother culture says that if you plant when the moon is young the tree may grow tall, but it will not give fruit, or blessings as they call it, or it will give very little, and if you plant when the moon is full even from a small tree you will obtain good fruit.

**Juan:** humm, bien, yo lo hice a propósito de las estaciones del año, sobre la posición de la Luna, la luna llena, la luna tierna, como le dicen por aquí (.2), nosotros observamos que hay cosas a las que la ciencia dice no, eso no es lo correcto sin embargo, aquí, desde nuestra cultura sí se cumple, como por ejemplo . . . la ciencia dice que tu puedes sembrar en cualquier tiempo, pero la cultura materna dice que si siembras en luna tierna el árbol puede crecer alto pero no da frutas, allá le llaman bendiciones, o da muy pocas, y si siembras en luna llena aún de un árbol pequeño, tendrás buenas frutas.

Juan talks of contradictions between science and Tzeltal culture regarding the relation between planting and the phases of the moon. It can be noted that he addresses the local knowledge as the legitimate one, at least in their context, through an emphatic empirical argument “this is how it happens.” This way, he relativizes scientific knowledge with an implicit questioning of the universality of scientific conceptions, giving voice to the community’s local knowledge (“but here”). He provides his empirical experience as a local test (about having “good fruit” if you plant when the moon is full). However, at the same time, he does not attribute a universal, impersonal, and objective nature to indigenous knowledge, since he categorizes it as a cultural and local knowledge point of view (“but here, from the point of view of our culture, that is how it happens”).

He places local knowledge in context and situates science as something that he seems not to totally assume. It can also be noted that with the expression of “our mother culture,” the teacher connects with his culture as a collective (our) and beloved possession conceptualized as where they came from. In this case, the logic of ancient knowledge conflicts with the logic of Eurocentric science. While indigenous communities refer to lunar phases to ensure their food supply and the sustainable use of land, those who incorporate Western scientific knowledge grow crops at any time of the year, harvesting to meet market needs and disregarding the environmental implications of their practices.

In this case, the indigenous knowledge can be classified in what George calls category number 4 since it cannot be explained in conventional scientific terms. Both knowledge systems are described in the teacher’s discourse, but he clarifies their tensions and irreconcilable differences, at least with regard to current scientific knowledge about planting.

In one of Stella’s lessons in a fifth grade of 41 students, a boy mobilizes Afro-Colombian knowledge through the voice of Don Miguel (played by the student), a knower of this culture that has been at the school, about the respect we need to give plants in order to obtain their healing action:

**B1 (Don Miguel):** If we pick, say, the *hoja de Cristo* to fight illness, we must first greet it.

**B2:** But, how do you greet plants if they don’t have ears?

**G:** (*she gets upset and sternly tells the children*) Well, children, what Don Miguel says is very true, since plants are living things and all living things feel and hear, even if they don’t talk the way we do.

**B1(Don Miguel):** There are things that science cannot understand. When you enjoy the benefits of a plant, you greet it as a person; if it's in the morning you say good morning, and if it's in the afternoon you say good afternoon.

**B2:** That's great, Don Miguel, I never learned that in the school in the capital city.

**Ao1 (Don Miguel):** Si cogemos, por ejemplo, la hoja de Cristo para lograr combatir las enfermedades hay que llegar y saludarla.

**Ao2:** Pero, ¿cómo se saludan las plantas, si ellas no tienen oídos?

**Aa:** (*se enoja y con voz fuerte dice a los niños*) Bueno mis niños lo que dice Don Miguel es muy cierto porque las plantas son seres vivos y todos los seres vivos sienten y escuchan, así no hablen como nosotros.

**Ao1 (Don Miguel):** Hay cosas que no entiende la ciencia. Cuando uno va a obtener los beneficios de la planta, la saludamos como a cualquier persona, si es por la mañana se le dice buenos días y si es por la tarde se le dice buenas tardes.

**Ao2:** Qué bueno Don Miguel, en la escuela de la capital no me habían enseñado eso.

This is a debate among children in Stella's classroom about what is scientifically known (plants do not hear because they do not have ears) and Afro knowledge (plants feel and listen as any living being does). It is interesting that boy1, playing Don Miguel, disqualifies science ("there are things that science cannot understand") and legitimizes Afro knowledge, which leads the other student to question the fact that he never learned that in the capital. The girl takes a strong stance supporting Don Miguel's assessment ("is very true") about plants as living things that can hear and feel. In this way, this classroom interaction among students questions the universal validity of scientific knowledge and validates the monistic perspective of indigenous knowledge (Barnhardt and Kawagley 2005). However, the children do not seem to merely repeat the information given by Don Miguel. They show their appropriation of the cultural perspective by being able to defend it, even denying the capability of science to understand "some things."

This excerpt shows the students addressing Afro-Colombian knowledge through a participant from the community. This knowledge is not recognized by the official Colombian curriculum, as boy2 points out in the final comment. It shows that boy2 accepts the Afro-Colombian version as legitimate knowledge ("That's great Don Miguel") after the argument given by boy1 about the importance of talking with plants and after some resistance from his previous scientific ideas.

In Tere's second-grade science lesson, similar conceptions about plants' sensitivity are mobilized:

**Tere:** But why should we take care of them (plants)? Let's assume that the plant does not cure my headache or anything like that, why should we take care of them?

**G:** Because when we pick them, they also feel pain.

**Tere:** pero ¿por qué debemos de cuidarlas (las plantas)? Vamos a suponer que la plantita no me sirve para el dolor de cabeza ni nada de eso ¿por qué debemos de cuidarlas?

**Aa:** porque cuando las cortamos ellas también sienten dolor.

It is interesting to note that after a question from the teacher asking why the children have to take care of the plants, a 7-year-old girl mentions that plants can feel pain when they are cut. The teacher's question is talking about why they have to take

care of plants when people cannot use them for curing certain illnesses. But the girl's answer changes the orientation of the discursive interaction from people's use of the plants to plants' feeling. This very young girl is showing local cultural knowledge more likely learned in her Purépecha community context than at school; her people's way of being, thinking, feeling, and expressing; and their particular conception of the world and life. The claim that plants feel pain establishes a connection between Purépecha and Afro-Colombian cultural knowledge, as both acknowledge that plants can feel. Stella and Tere seem to share this interpretation of plants' feeling because they do not make any connection to scientific knowledge.

We include another excerpt in which Stella explains to the interviewer the difference between Afro-Colombian and scientific knowledge, as stated by an Afro leader in the classroom:

**Stella:** The Afro woman told the whole story of plants as they relate to witchcraft and magic. The girls especially were so excited, since they assimilated it all into their affective circle, their passions, their love interests, and their boyfriends.

**Stella:** La mujer afro contó toda la historia de las plantas en relación con la brujería y la magia. Las peladas (*las niñas*), sobre todo, eran re encantadas, pues ellas metían todo eso dentro de su círculo afectivo, sus pasiones, sus amores, sus novios.

The Afro-Colombian woman, called by the teacher to give her worldview to the students, mobilizes in the classroom the cultural uses that Afro communities assign to plants in rites of magic and witchcraft for curing illnesses and obtaining wishes. Stella mentions that these types of cultural knowledge fascinated the girls, because they were able to connect these plant rituals with their affective circles ("their passions, love interests and boyfriends") as cultural ways to build affective and spiritual relationships with nature.

The use of these plant rituals recalls the ideas of Battiste and Henderson (2000: 43), when they said that Eurocentric researchers may well know the name of an herbal cure and understand how it is used, but without the ceremonies and rituals, they cannot achieve the same effect. They argue that the difference between these systems of knowledge is based on the contrasts between Eurocentric reductionism and Afro-Colombian holism.

This Afro and indigenous knowledge of plants seems to be mobilized through cultural practices that tie together nature, spirituality, and ancestral culture and cannot be explained in the terms of conventional science. These excerpts are representative of indigenous knowledge characterized as number 4 by George, because they show processes where participants construct irreconcilable Western and non-Western meanings for the same concept. The students know that science affirms that plants need physical factors (such as water, light, soil, air) in order to grow. However, those scientific ideas coexist with their cultural system of knowledge that plants also feel pain and need affective and spiritual relations with human beings, knowledge which has epistemological bases that differ from those of science.

## 14.7 Final Thoughts

In Latin America, there are processes of staking out positions and engaging in activities and discourses that constitute anti-epistemic movements in favor of preserving ancestral knowledge from our aboriginal cultures and mobilizing it in schools (López 2001; Godenzzi 1996). Science classes, particularly in the underserved Afro-Colombian and indigenous communities we study in this paper, are meeting places where Western science is enriched or confronted with different cultural knowledge systems, especially about different relationships with nature, brought in by teachers, students, and community members.

It is noteworthy that almost all the indigenous and Afro-Colombian knowledge brought to science teaching in this paper can be classified as category 4 as proposed by George (1999). This could suggest that these teachers' selection of what content to incorporate might be driven by the objective of working with certain ideas and knowledge that they consider relevant for preserving their culture, regardless of whether or not it can be reconciled with scientific knowledge. Their concern is to form their students within the culture of their community of origin rather than to assimilate their knowledge into science.

In the interviews carried out with Mexican indigenous teachers (Tere and Juan) and an Afro-Colombian teacher, we found that all openly manifest a responsibility to nurture science lessons with the cultural knowledge of the community in which they live and teach. The commitment to preserve local culture has to do with the teachers' perception that indigenous and Afro-Colombian cultures are under threat, marginalized and excluded from the official national curricula. Tere talks about customs that must be rescued and strengthened for Purépechas to survive. Stella mentions that Afro-Colombian culture is the least present in school and talks about the importance of rejecting manifestations of racism by some students toward others because of their skin color. Juan emphasizes the importance of maintaining their history and culture, but above all, the values that science cannot give them, and allows them to discern which contributions of science to accept and which to disregard, depending on the impact on their community. These teachers come up with similar forms that can be defined as resistance when confronted with the alleged homogeneity of neoliberal globalization in different contexts—Michoacan and Chiapas in Mexico and Bogota in Colombia.

All three teachers show a commitment to their students that is not only pedagogical but also ethical, as they consider it important to promote their self-recognition as indigenous or Afro-Colombian, so that they can act with awareness of what they have and who they are, of their own histories and cultures, in what could be called the construction of their cultural identity. Contributing intentionally to the self-affirmation of one's identity by expressing appreciation in school for worldviews from non-dominant communities is an educational commitment: these teachers stand up to the powerful dominant system as a resistance to be culturally ignored advocating for the preservation of their cultures, knowledge, practices, and values. The cultural knowledge systems teachers bring to the science lessons are shared with the students, as shown in their interventions.

One of the main interests the teachers openly express is their opposition to the anthropocentric notion of science when it comes to the natural world (Stella) and the irrational exploitation of nature endorsed by the scientific and technological perspectives, which differs from the sustainability promoted by the ancestral knowledge of the indigenous and Afro cultures. In Stella and Tere's classrooms, the voices of members of their communities (Afro woman and Don Miguel) are mobilized in school in order to develop a spiritual and holistic relationship with nature. It is noteworthy that the girls are fascinated by the rituals and magical conceptions of plants, and tie this knowledge to their passions and interests, relating inner space (the spiritual world) with outer space (the physical world), as a contribution to the construction of holistic and harmonious systems between human beings and nature. These examples recall the monistic spiritual thinking behind Afro and indigenous knowledge as a process of *desettling* expectations in science education as described by Bang and Marin (2015), opening possibilities of learning for these students as shown in their increasing participation in classroom interaction. In the literature it has been noted that indigenous students feel a sense of foreignness toward science (Brandt 2007). It seems that the mobilization of their cultural knowledge could be a way to counteract indigenous students' sense of alienation.

Teachers' participation enriches science education through autonomous enculturation when they construct forms of coexistence between science and indigenous and Afro systems of knowledge without avoiding or subordinating either of them. It is perhaps an initial form of relationship among different systems of knowledge, with teachers and students interested in legitimating in the formal space of school different cultural ideas that their community has about the natural world. They seem to be asserting the legitimacy of a certain kind of ancestral cultural knowledge in school, particularly their relationship of respect for, and communion with, nature.

It is important to point out, as Aikenhead and Owaga (2007) suggest, that the teachers mobilize and establish an indigenous and Afro-Colombian knowledge that can make predictions and acknowledges an experientially grounded worldview (differences in the growth of crops planted under the full moon as opposed to the new moon), just as scientific knowledge is legitimized. In these examples, community knowledge is mobilized in schools, transforming them from being institutions that only represent the national state perspectives on knowledge to institutions that also represent the proud knowledge of the local community when the teachers convoke its cultural voices.

Following Bakhtin's work (1981), we can say that teachers' discourse creates an implicit dialogue among multiple voices: the official voices represented in national curricula, the ancestral voices of their cultures, the concrete voices of the community where they work, children's voices, and our voices as interviewers. However, when it comes to nature, much scientific knowledge is presented as irreconcilable with the knowledge of these communities, because of their very different epistemological foundations. Such is the case of the mobilization of knowledge regarding the relationship between planting crops and the phases of the moon, the sensitivity of plants, and people's spiritual and emotional relationship with them and in harmony with nature overall. They do not separate matter from mind, and thus they believe that plants have sensitivity (they hear and feel pain) (Cajete 2000).



By legitimating nonscientific perspectives on the natural world, the teachers are implicitly questioning Western scientific knowledge as the only true and universal kind. The teachers do not always propose denying scientific knowledge—at several times they insist on the importance of teaching it—but they affirm the relevance of indigenous and Afro knowledge, especially at the local level (“here, from the point of view of our culture”). By appreciating different kinds of knowledge about certain topics, they make at least a partial break with positivist science and an initial intercultural science education perspective. In this way, the analyses we present here can be seen as examples of dialogic and critical teaching of science in public schools in indigenous contexts. Each of these teachers opens opportunities to construct harmonious, holistic, relational, and complementary ancestral approaches to nature and ways of relating to it that go beyond Eurocentric scientific knowledge.

If it is accepted that schooling is a continual production and reformulation of cultural practices depending on the cultural endeavor of the institution as well as the cultural origin of teachers and students (Candela et al. 2004), then we can say that these teachers challenge and transform the epistemological perspective of the official science curricula in Mexico and Colombia when they contextualize and dispel the myth of the universality of scientific knowledge. They resist the colonial imposition of only one version of the natural world by claiming as legitimate the indigenous and Afro-Colombian knowledge that tries to be harmonious with nature (Aikenhead and Michell 2011).

The data also show that the knowledge and purposes manifested by the teachers seem to be quite similar in the two indigenous communities in Mexico and in the Afro-Colombian community, suggesting the possible existence of cultural roots shared by these ethnical communities.

However, it must be noted that all the teachers studied in this paper share a cultural background that is not limited to strict scientific formation. They share the cultural perspective of the community where they teach. This can be an explanation of their active participation in the preservation of their cultural references. Whether a culturally sensitive perspective for science education can be extended to teachers that do not have cultural backgrounds other than scientific formation is a pending research question.

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