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Science Teachers' Conceptions About the Importance of Teaching and How to Teach Western Science to Students from Traditional Communities

Geilsa Costa Santos Baptista[1] · **Adela Molina-Andrade**[2]

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Abstract
We discuss the results of a qualitative research with science teachers that serve students from traditional communities. The aim is to analyze their conceptions on the importance of teaching and how to teach Western science to students from these communities. Data collection is carried out through semi-structured interviews with four teachers who work in a public school in the state of Bahia, Brazil. The analysis starts from the construction of narratives, generating thematic categories and epistemic positioning of teachers' conceptions. The results indicate that, for those teachers, teaching Western science to students from traditional communities is important for the expansion of their knowledge and their active participation in different sociocultural environments, through methods that include intercultural dialogue. However, their answers have contradictions, which allow us to infer that their conceptions transit into the four epistemic positions on science teaching and cultural diversity: Epistemological Pluralism, Interculturalism, Multiculturalism, and Universalism, with the first two being the most emphasized. This reveals a dilemma between what they conceive as goals and links for science education, and what they practice as teachers, which is possibly influenced by school pedagogy provided by public policies of national education. We consider implications of these conceptions and positions for teacher education and science teaching sensitive to cultural diversity.

Keywords Western science teaching · Traditional communities · Teachers' conceptions · Intercultural dialogue

Introduction

Science teaching has been a major challenge for many students from different cultural backgrounds. This does not result from the exclusive nature of Western science that makes up the school curricula, but from the privilege given to it in relation to other ways of knowing,

✉ Geilsa Costa Santos Baptista
geilsabaptista@gmail.com

[1] Department of Education, State University of Feira de Santana, Feira de Santana, Bahia State, Brazil

[2] Faculty of Science and Education, Francisco José de Caldas District University, Bogotá, Colombia

that is, scientism (Cobern & Loving, 2001). As a result of these didactics, many students are hardly able to perceive contextual meanings in scientific content, being uninterested in science classes.

In schools located into traditional communities, students' disinterest occurs not only in the scientific knowledge, but also in the cultural knowledge of their social environment. A survey carried out by Baptista (2007) with Brazilian farmer students at a school located in the municipality of Coração de Maria (Bahia state) revealed that most of them migrated from the countryside to large urban centers because they did not want agricultural work, believing that they would receive better payment to their own livelihood and to assist their families. These results are confirmed by Robles-Piñeros (2017), which reveals that young farmers of Coração de Maria, after migrating from the countryside and failing to achieve the desired economic ascent, returned to the farm, and once again faced difficult living conditions and poverty, associated to low productivity due to problems linked to "agricultural pests." A similar study was carried out by Ladio (2001) with the Mapuche indigenous of the Patagonia (Argentina), which indicates that many young people migrated away from the forests their ancestors inhabited, generating a progressive decrease in knowledge about the useful plants in their community.

This could be related to each country's public education policies and to teachers' conceptions about the objectives and methods adopted for teaching Western science. The teachers' conceptions exert strong influences on their methodological forms of teaching and can be both, a facilitator, and an obstacle to the understanding of contents (Tardif, 2012).

In the case of traditional communities, we believe that teachers' conceptions can contribute both, to the expansion of traditional knowledge with scientific knowledge through intercultural dialogue, and to scientism, with attempts to abandon traditional knowledge in favor of scientific knowledge (Baptista, 2010).

According to Aikenhead and Huntley (1999), to allow changes in teaching and learning processes, appropriate to the development of culturally diverse school education, it is first necessary to investigate the teachers' conceptions on this subject. From that, emerged the following research questions: – *In the conceptions of science teachers who work and/or who serve students from traditional communities, what is the importance of teaching Western science, considering their cultural particularities and ways of life? – Do these teachers consider as important the establishment of relationships between school scientific knowledge and other forms of knowledge? – If so, what methods do they use or indicate for this to happen? – What are the implications of science teachers' conceptions about the importance and means of science teaching for teacher education that is sensitive to the cultural diversity in classrooms?*

It is important to highlight that when we are questioning the importance of teaching, we are referring to the objectives of teaching Western science. The "how to teach it" is materialized in the methods applied by teachers to teach Western science, that is, in the set of resources, procedures, environmental conditions, etc., which are adopted to work the contents and achieve their objectives. According to Libânio (2006), the methods are, or should be, determined by the objectives, because it is up to the methods to dynamize the conditions for the realization of teaching. Our reference to schools that serve students from traditional communities is related both to schools located in these communities and those located outside them, into urban areas and that receive students from traditional communities (Caldart, 2004).

We discuss the results of a qualitative research that aims to present the "importance of" and "how to" teach Western science to students from traditional communities based on the

conceptions of science teachers who serve those students. This paper is the result of a post-doctoral research in Education, developed in the Faculty of Education, Francisco José de Caldas District University (UDistrital), Colombia.

The expression "traditional communities" involves human populations that, throughout their historical process, developed and still developing modes of existence, adapted to specific environmental circumstances, which are transmitted from generation to generation, often through orality (Diegues & Arruda, 2001). By Western science, we agree with the definition of Cobern and Loving (2001), of being one among the numerous existing cultural activities; one of the characteristic ways of knowing in Western societies, which has its own language, values, contexts of origin, and applicability that differ from other ways of knowing the world, such as traditional communities.

According to Molina-Andrade et al. (2014), many studies have been carried out in the field of education and science teaching on teachers' conceptions, but few of these studies are directed to cultural diversity. Thus, the need to carry out the research reported here arose by the experiences lived by the authors into the field of science teaching and teacher training to deal with cultural diversity in Latin American schools. We made a literature review covering from 1990s to the present, particularly in the Brazilian and Colombian context, including research on issues related to ethnobiology, history and philosophy of science, and intercultural dialogue. This review did not reveal works in the field of science education that explicitly and directly addressed the conceptions of science teachers, who teach students from traditional communities about the importance of and how to teach Western science. However, several works can be considered, as Molina-Andrade and Mojica (2013), Valderrama (2016), Robles-Piñeros (2017), Bernal et al. (2018), Valadares and Pernambuco (2018), Baptista (2018), Quintriqueo and Quilaqueo (2019), and Araujo and Baptista (2020) to construct dimensions and analysis for the conceptions. Such dimensions refer to the practices of teachers in which they consider epistemological, ontological, and ethical aspects, to overcome the discrimination of local and traditional knowledge through intercultural dialogue associated with biodiversity and biocultural memory.

Some works were found at the international level, such as Dziva et al. (2011) and Aikenhead and Huntley (1999), which, in general, show that teachers who work in schools that serve aboriginal and indigenous students, conceive Western science as a curricular content, a way of exploring nature, having its knowledge superior to traditional knowledge, and that these conceptions are influenced by the science teaching curricula of schools. Dziva et al. (2011) report that for Mberengwa teachers from Zimbabwe, Southern Africa, traditional knowledge makes it difficult to understand Western science, as it promotes misconceptions by students. These results show that teachers do not understand Western science as a cultural activity of scientists, that it has its own values and applicability contexts, and although traditional knowledge does not have universal purposes like Western science, it can and should be considered in classrooms through intercultural dialogue, as a way of respecting its values, local applicability, and cultural identities, which may constitute a basis to expand it with scientific knowledge.

We take a stand and defend scientific education in and for traditional communities that recognizes and respects the epistemic diversity in classrooms, which should be intercultural, problematizing the interpellations between scientific knowledge and practices, and traditional knowledge and practices about nature. A scientific education that aims to train scientifically literate citizens, in the sense of expanding their cultural knowledge with scientific knowledge, being increasingly able to act critically and autonomously in the face of the complexities of their own sociocultural environments and those who are scientifically and technologically influenced, without, however, being compelled to deny the knowledge

and practices that integrate their cultural identities, by an alleged epistemic superiority of Western science (Baptista, 2018; Cobern & Loving, 2001; Molina-Andrade & Mojica, 2013).

Data presented on this paper has academic relevance as it may contribute to further research and understanding of science teachers' conceptions, epistemologies, and pedagogical practices. It also may propose new models for their training processes that involve teaching and learning Western science, which aims to respect and consider the cultures of traditional peoples. This paper has social relevance, as it gives voice to science teachers, opening spaces for exhibitions and reflections on their own conceptions, that could expand their knowledge about teaching and pedagogical practices committed to intercultural scientific education.

Theoretical Framework

Science Teaching in Schools Serving Students from Traditional Communities

In Latin America, persist attempts at cultural homogenization to replace traditional knowledge with scientific knowledge, although hundreds of years passed since the period of colonization by Europeans, and much is advocated against the imperialism of Western science (Toledo & Barrera-Bassols, 2008). This is clearly manifested in the processes of globalization, as a capitalist economic model that consists in the interrelationship and interdependence of territorial borders in different areas. As a result, people from different countries and ethnic origins live with hierarchical and discriminatory relationships (Cobern & Loving, 2001).

For Suciu et al. (2014), globalization, together with scientific and technological advances, has been impacting humanity, challenging people to move into global societies and, at the same time, to preserve their diverse identities. Berkes (1993) and Kimmerer (2002) argue that many traditional communities (indigenous, artisanal fishermen, family farmers, *quilombolas*, riverside dwellers, etc.) have resisted and still resist the supremacy of colonialist Western science, producing, applying, transmitting, and renewing knowledge among their members, which is useful to guarantee the experiences of its members and to protect the biocultural heritage of their surroundings. A good example is the Uitotos, indigenous people who live into the Amazon interfluvial forests of Brazil, Colombia, and Peru. The Uitotos—despite being enslaved, decimated by disease and murder, requiring the survivors to flee their villages by years—still speak their own languages and live in direct interdependence with nature. For the Uitotos, as for many indigenous peoples, the world is an eternal and harmonious unity, where everything is interconnected and inter-influenced, which demands respect and care for nature (Castaño-Cuéllar, 2015).

Therefore, the science teaching of schools that serve students from traditional communities must stop the attempts to replace traditional knowledge with scientific knowledge. Knowledges that are traditional in the communities where students live, as well as the scientific knowledge, have their own epistemologies and ontologies, their own meanings, contexts of origin, values, and applicability; they must be respected and considered in the processes of teaching and learning science to expand their views of nature, and not to cancel them out (Baptista, 2018). Traditional knowledge deals with themes related to the natural world, which are also of interest to Western science, such as the conservation of natural resources. According to Leff (2001), traditional communities carry important knowledge

about the use and management of natural resources, which are created and renewed for specific purposes of maintaining the ecosystems where they live and on which their lives depend (Leff, 2001).

Western science is didactically recontextualized from the academic environment to the school environment (Marandino, 2004), representing school scientific knowledge, it is important to master the scientific language, or scientific literacy. This is because scientific and technological development has been entering and increasingly impacting societies around the world, especially through the numerous means of communication and information, which requires from the subjects, the mastery of scientific language for its meaning, criticality, and decisions making (Orlandi, 2011).

In any school's reality, the scientific literacy must aim at understanding the scientific language and the culture which it belongs to. That is, the expansion of the conceptual profile of students with scientific concepts (Mortimer, 1996), when they begin to master science, being able to make decisions with freedom of choice about whether to use it or not. Because scientific knowledge can help people solve many everyday problems (Manassero et al., 2002), but not all, since science, as well as other ways of knowing, has strengths and limitations (Aikenhead & Lima, 2009). Science does not have answers to all questions of humanity; the same as traditional communities, but both could have their knowledge complementary to each other.

In the case of traditional agricultural communities, according to Baptista (2007) and Robles-Piñeros (2017), through intercultural dialogue, science education can contribute to critical reflections and choices about which knowledge, scientific and/or traditional, those communities will use to solve problems related. For example, with insects affecting plantations, they can be attacked with "cow urine," chemical substances or living organisms, considering here their consequences for plants, the soil, and human health (Baptista, 2007; Robles-Piñeros, 2017). This can help students and their families to increase agricultural productivity and to avoid their migration in search of salaried works due to problems in agriculture, but rather to leave them more skilled in dealing with issues, and be motivated, valuing their cultural identities.

Teachers' Conceptions and Their Influences on Teaching

To think about scientific literacy as well as about intercultural science teaching also means thinking about the conceptions of science teachers about this topic. For Nuñez et al. (2009), research on teachers' conceptions can help in the construction and proposition of new models for their training, especially based on their own teaching epistemologies and, therefore, new conceptions and actions of the processes that involve teaching and learning science from an intercultural perspective. Matos and Jardalino (2016) define conception as the way in which a person perceives, assesses, and acts in relation to a given phenomenon, building concepts. It is the representation of thinking about a phenomenon that contributes to the formation of personal theories. In the case of teachers, conceptions constitute their implicit theories, that is, their individual and unconscious constructions, which are the result of their sociocultural relations and experiences in academic and school environments and that determine their objectives and methods of teaching (Pozo, 2002).

Teacher training for intercultural scientific education requires investigating how these professionals conceive science teaching, if they accept the universal, scientific, and decontextualized ideologies of Western science; if the meanings of science for science teaching are relativized, so all knowledge systems that are cultural are considered science or are

located in Western science, teaching it as a specific way of knowing that can and should establish relationships with other cultures, questioning their contexts of origin, meanings, validity, and diverse cultural interests. According to El-Hani and Sepúlveda (2006) and Molina-Andrade et al. (2014), there are four epistemic and didactic points of view, which are subjects of intense debate between educators and researchers in the field of science education since the 1990s, which question whether non-Western cultures have or not knowledge about nature that can be considered science, and whether this knowledge should be included in the school curriculum or just in science classrooms, namely, Universalism, Multiculturalism, Epistemological Pluralism, and Interculturalism.

For Universalism, reality has the last word. It is the adaptations of its statements that grant Western science an epistemic power, superior to other forms of knowledge; as certain phenomena of nature are indifferent to all human beings, so also the flows of science will be the same for everyone. These characteristics imply science teaching centered on the transmission and memorization of scientific theories and concepts. Science, as a body of knowledge and activity, has a universal character and cannot be taught in multicultural terms. Science curricula and classrooms should only include Western science.

For Multiculturalism, Universalism represents a policy of exclusion that is wrong from an epistemological, moral, and political point of view. It proposes the inclusion of the Traditional Ecological Knowledge (TEK) in the science curriculum. Scientific education must be multicultural and there is no compatibility with an education plan that is universalist. Science means the rational perception of reality, so other knowledge systems besides Western science are science and have the same value. It is necessary to consider the plurality of reasons to understand science education, the world.

Epistemological Pluralism rejects the scientific relativism of Multiculturalism, according to which all knowledge organization systems are science and do not accept discrimination or overvaluation of Western science, as occurs in Universalism. Scientific knowledge is the result of a specific way of knowing, socially and culturally situated, and must be understood within their own sociocultural contexts, requiring the demarcation of the discourse of science in classrooms, which, in most cases, means in part, a second culture for students. Both science and traditional cultures constitute different ways of producing knowledge, which can be valued on their own merits and contexts of use. This is not an overvaluation or devaluation of Western science, but rather to recognize its limits and scope, just as it is necessary with other ways of knowing. It is necessary to conceive the cultural complementarity in science teaching. The intention is to encourage pluralism that always allows coexistence and conversations with negotiation of meanings about what is considered important.

The arguments of Interculturalism are like Epistemological Pluralism and prioritize the crossing of cultural borders, as this already happens with students who attend science classes in urban Western contexts, who participate in different cultural subgroups, defined as "race," ethnicity, language, gender, social class, working class, religion, etc. It is necessary to establish bridges between knowledge from different cultural origins; school scientific knowledge is configured from the relationships with students' experiences and cultural knowledge, which must be incorporated into classrooms. It seeks the interactive quality of these relationships and not a mere coexistence in the same space; it does not ignore the power relations present in social and interpersonal relations; it recognizes and assumes conflicts, looking for the appropriate strategies to face them.

It is important to mention that we, as researchers, reject Universalism, for its scientism and hierarchies in relation to other ways of knowing, and Multiculturalism, because although it is against scientism, it does not explicitly aim at the encounter and dialogue

between different knowledges within cultural diversity. We assume the Pluralist Epistemic and Interculturalist view that, in general, recognize the existence and values of other ways of knowing beyond Western science, pointing to the need for dialogues that admit conflicts as a starting point for the negotiation of meanings and their importance, expanding the possibilities of interpreting the world with respect for cultural identities.

Intercultural Dialogue in Science Education

Traditional communities have specific ways of knowing, which often differ from the ways in which Western science and its subdivisions explain nature. Therefore, it is not productive for science teaching in and for these communities to be scientific and not relativistic, but rather plural from an epistemic, ontological, and intercultural point of view. The scientistic position is authoritarian and aims at the annulment of traditional knowledge in favor of scientific one, which can result in the overvaluation of science, and the denial of their own cultural identities. Multiculturalism, on the other hand, is relativistic, as it considers all knowledge in the classroom as science, and being equal; they have the same meanings and uses, and can lead students to hybridize scientific knowledge with traditional knowledge.

As Pérez-Ruiz (2016) well argues, the hybridization of knowledge is a problem for traditional communities, specifically the indigenous ones, for their autonomy in collaborative and decolonizing actions, in the sense of being able to distance themselves from the attempts of cultural homogenization by European colonizers. It is indeed a dialogue in which the knowledge involved does not lose its own logic. This does not mean that scientific knowledge should assume the logic of indigenous knowledge; so indigenous knowledge does not lose their ontological elements to assume the scientific perspective logic (Pérez-Ruiz, 2016).

Relations with students from traditional communities, as well as from any sociocultural environment, need a science education that considers the existence of different ways of knowing through the realization of dialogue, that allows the teacher to teach scientific knowledge and, at the same time, open spaces for other knowledges to be exposed. These are spaces and moments for each subject to make their representations based on their own epistemologies and within purposes that are agreed upon for the interaction between different meanings (Pérez-Ruiz, 2016).

There are several meanings for the term dialogue, being, therefore, polysemic. The word dialogue comes from the Greek *dialogos*. *Dia* means "through," and *logos* means "the word," or rather, "the meaning of the word" (Bohm, 1996). Thus, in general, dialogue is the exposure of words and their meanings flowing between people or with a single person, in the sense of having a dialogue with oneself (Bohm, 1996).

In science education, dialogue is the exposition of words and their meanings flowing between teachers and students, and between students, about a certain topic/content that is the object of study in science classrooms (Baptista, 2010). Dialogue does not mean taking a relativistic position, of having to teach Western science that is recontextualized for school (school scientific knowledge), and at the same time, to teach the cultural knowledge that students carry with them to the classroom. After all, science teachers have their academic training to work in schools whose curricula are composed of Western science and, in addition, it is exceedingly difficult for them to master all knowledge systems beyond their own culture of origin and of the scientific culture that trained to be teacher. Dialogue is to communicate scientific knowledge, opening opportunities for exposition of other knowledges present in the classroom, with

negotiation of how they relate to scientific explanations, whether in terms of similarities and/or differences in ancestry, meanings, and applicability.

The word negotiation is of Latin origin, *negotiatus*, which means "taking care of business." Negotiation is a relationship process aimed at reaching an agreement between the parties, which can happen with or without the involvement of conflicts. In dialogue, there is no competition, in which it is understood that one participant has more knowledge than the other, in an asymmetrical, unilateral, and hierarchical relationship, but rather, there is collaboration, in the sense that each interlocutor is free to present their own knowledge, being necessary to establish reciprocity agreements so that takes place the construction of contextual knowledge with ethical development.

For Kato and Kawasaki (2011), the term contextualization of teaching is polysemic, not only in the context of teachers' conceptions, but also in the science teaching literature and in the documents that guide school curricula. In this work, we understand by contextualization of teaching the linking of contents, curriculum themes in times and places of origin, and application for the generation of meanings, which may be in the students' daily lives, between, and through school subjects and in science, in their historical and epistemological aspects (Kato & Kawasaki, 2011).

Through dialogical communicative approaches, it is possible to encourage students to expand their sociocultural knowledge with scientific knowledge, instead of using authoritative discourses that try to nullify one in favor of the other. As an example, in the transmissive and scientific pedagogy, linked to a curriculum that does not allow going beyond the transmission of decontextualized content and of repetitions, as if learning consisted in reproducing the content in school assessments.

Expand students' sociocultural knowledge in the sense of understanding and mastering an additional way of knowing (Western science) together with their prior knowledge, that are cultural. The expansion will constitute the scientific literacy of students, as they will not feel to be forced to break with their prior cultural knowledge. They will be able to carry out their critical participation and decision-making in different spaces where science and its products are or are not present, in or out their communities. For this, the teacher will be able to work on the epistemology of science, communicating how scientific knowledge is constructed, the importance of collaboration in scientific work, the interests that influence scientific practices, their contexts of applicability, etc. It may involve everyday situations of traditional communities to make observations of the natural world, to try and identify problems, to ask questions, and find suitable answers. By then, they will be able to negotiate the feasibility of applying scientific knowledge or their traditional knowledge, encouraging students to think critically, being able to see scientific advances in an ethical and reliable way.

Methodology

Research Focus

It was a qualitative research based on symbolic interactionism (Alves, 1991; Creswell, 2014; Smit & Fritz, 2008). A descriptive research of teachers' conceptions who work at the levels of Elementary (Science curriculum component) and High school (Biology curriculum component) of a public school located in the municipality of Coração de Maria (district of Retiro), Bahia state, Brazil. Symbolic interactionism, "[…] enables the understanding of how individuals interpret the objects and another people they interact with, and how

such an interpretation process leads to individual behavior in specific situations" (Carvalho et al., 2010, p. 148). Our purpose a priori was not to confirm or nullify hypotheses, but to build them during data collection and analysis.

Location, Subjects, and Ethical Considerations

According to the Brazilian Institute of Geography and Statistics (IBGE, 2021), the municipality of Coração de Maria is located between the biomes of *caatinga* and Atlantic Forest, 113 km from the city of Salvador, capital of the state of Bahia. It has an area of 378,420 km^2 and 22,495 inhabitants, who live from livestocking, trading, and agriculture, being the last, the more intense one, despite the many related problems.

Agriculture in Coração de Maria was once more intense, being considered the largest producer of pineapples of the Brazilian Northeast. Information collected from the local population indicates that, in the past, farmers knew more about the problems linked to local agriculture, specifically about the specific pests, and were able to fight them with natural methods that helped to plant and harvest in large scale. However, when the Bahia's state government implemented agricultural technical support, producers became accustomed to seeking solutions with these institutions and, thus, their ancestors' knowledges on the subject were lost (Baptista, 2007).

Coração de Maria is divided into three concentrated areas: the Center, where the administrative sector is located (City Hall) and the farmer districts of Retiro and São Simão. It is customary for the residents to celebrate their cultural traditions in the month of June (June festivities), especially linked to the local agriculture (the harvest month), when *forró* dances and chants are displayed in honor of Saint John.

From the public schools located in Coração de Maria, we chose to work with the *Colégio Maria José de Lima Silveira*, located in the Retiro district. The school is in the countryside and caters exclusively to students who are farmers or children of farmers living there. It operates in the morning, afternoon, and evening shifts, covering three modalities: Elementary, High School, and Youth and Adult Education (EJA). The municipality of Coração de Maria is part of a research project being developed by the first author at the State University of Feira de Santana (UEFS, Brazil). The objective of this research project is to describe and promote teacher training and intercultural teaching of natural sciences and biology in traditional communities to contribute to scientific literacy and decision-making by farmer students in Coração de Maria. It is aimed to assist the continuing education of teachers and involves ethnobiology, history, and epistemology of science as a contribution to intercultural dialogue. It was approved by the Ethics Committee for Research Involving Human Beings (CEP-UEFS) with number 2.471.094/2018; the Higher Council of Education, Research and Extension (CONSEPE-UEFS) with number 097–2018; and it is registered into the Brazilian National System for the Management of Genetic Heritage and Associated Traditional Knowledge (SisGen), by the number AB1A096, of August 2018.

Four teachers of Elementary and High School participated on the research. They agreed by signing a Free and Informed Consent Term (TCLE), according to the national standards for research involving human beings (Brasil, 2016). Each participating teacher received pseudonyms to guarantee their privacy, and according to their own indications. Thus, the pseudonym Paula was assigned to the first teacher interviewed; the second Denia; the third Maria; and Sol for the fourth participating teacher.

Data Collection

The first step consisted of preparing the interview protocol (Table 1), with questions arising from situations inherent to the realities experienced by the teachers (Brousseau, 2008) as proposed by Molina-Andrade et al. (2014) for research involving science teachers to deal with cultural diversity. Each situation was scored based on data obtained from investigations carried out by the first author and under her guidance in schools of Coração de Maria (Araujo & Baptista, 2020; Baptista, 2007; Robles-Piñeros, 2017), about the meanings of Western science and the importance of intercultural dialogue for science education.

Source: Research results.

The interview protocol was validated by the Research Group in Ethnobiology and Science Teaching (GIEEC-UEFS)—which currently comprises 29 members, including undergraduate, master's and doctoral students, and public-school teachers in the state of Bahia—and by two research professors, specialists in the field of science teaching and interculturality in farmer schools. The next step was to carry out a pilot interview with a teacher of natural sciences and biology of a public school in the state of Bahia, located in the municipality of Ipirá, and which serves mainly farmer students and/or children of farmers, from the same municipality.

After the online validation and the test, we continued with the application of the interview with the four science and biology teachers at the school under study. Given the restrictions of the COVID-19 pandemic, which in Brazil affected the 2020 academic calendar (year of development of this research), and the impossibility of face-to-face meetings with teachers, we resorted to netnography, that is, an ethnography, description of the human behavior in social groups, linked to online work (internet) and which allows the use of different forms of communication mediated by digital technologies (Kulavuz-Onal & Velasquez, 2013).

Each interview lasted between 40 and 60 min. It was conducted and recorded over the internet, by Google Meet®. By reading and listening to each situation in Table 1, the teachers were able to freely present their answers. Among the four participating teachers, one requested that her interview was carried out through WhatsApp®, as she was having difficulties to get connected from a computer. Thus, the questions for this teacher were sent orally by WhatsApp®, and then, the teacher returned her answers again in audio format.

Data Analysis

For Silva et al. (2011), according to the researcher's interest, his/her conceptions can be analyzed using different methodologies. The research reported here involved four stages. In the **first stage**, each teacher's interview was carefully listened and transcribed into the Microsoft Word® text editor. In the **second stage**, a narrative was built for each participating teacher in order to analyze their conceptions about science teaching and cultural diversity, as proposed by Molina-Andrade et al. (2014) based on the use of narratives by psychologist Jerome Bruner, to understand human thought (Burner, 2002). According to Bruner (2002), narrative is a unique sequence of events that is loaded with contextual meanings, involving human beings as characters or authors. Molina-Andrade et al. (2014) argue that narratives are made up of contexts that give meaning to the individual world captured by the subjects.

The narratives consisted of (i) our interpretations of teachers' answers (content of the interviews); (ii) excerpts from their responses; and (iii) our experiences and knowledge

Table 1 Semi-structured interview protocol conducted with science and biology teachers

Situation 1. Maria and José are brothers and practice family farming in the state of Bahia, Brazil. They are attending High School (students aged between 15 and 17). One day, when they arrived in the classroom with reddish spots and itching all over their bodies, they sought help to the biology teacher to understand what was happening to them. The teacher asked them about their food, and José replied that they eat every day the plants they cultivate and the farm animals they grow. They also reported that they began to feel unwell after lunch that day, when they ate a salad with lettuce. At that time, Maria complained that her mother said that the problems began to emerge after the community where they live started using chemical products, stopping using cow urine and other knowledge of the elderly to fight "agricultural pests". The teacher thought and soon suspected that the students were intoxicated, possibly using some agricultural pesticide
Question 1: If you were the biology teacher, how would you conduct a class in front of this situation?
Situation 2. In an activity of pedagogical coordination at the school, teachers were asked to point out goals for teaching science at school, as well as methods to achieve them, to avoid the exodus from the countryside by young students, who are farmers. This guidance resulted from a meeting with the parents of these young people, who justified the departure of their children to large cities (urban centers) after completing High School and due to the lack of production and enough financial resources to support their families. According to these parents, the lack of production rises from numerous problems in local agriculture, such as the impoverishment of the soil, emergence, and lack of control of "pests", low prices for agricultural products and the government's agricultural policy that does not guarantee permanent access to pesticides and fertilizers. In addition to these factors, parents reported that young people are attracted by large urban centers, because they consider life in the countryside to be bad, and they no longer want to work in agriculture. Parents complained that the school does not prepare their children for the world of work, to national universities admission test, nor to deal with the problems inherent to local agriculture
Question 2: In view of this reality and the coordinator's request, please explain what objectives you would score for science teaching (the curricular components you teach) and what methods would you use to achieve them if you were a teacher at that school?
Situation 3. A group of teachers was planning the contents that should be worked on in science (Elementary school level) and biology (High school level) classes during the year. As it was a school whose students were farmers and/or children of farmers, the teachers knew that they needed to contextualize the knowledge so that it would have meanings for children. Thus, they scored several themes, voting on what would be the contents to be taught
Question 3: Please, among the themes below, choose whose you, as a science teacher, would consider to be important for contextualization in the classes and justify the reason for the choice: 1) adaptation, evolution, and natural selection; 2) earthquakes; 3) waste treatment; 4) global warming; 5) pandemic by COVID-19; What alternatives would you propose?
Situation 4. At the end of a school unit, the mother of a young farmer student approached the school's pedagogical coordinator (science area) questioning her daughter's low grade in the science assessment: "Mrs., I am here to know why did my daughter get such a low grade if there is a question on her test that is correct, and the science teacher considered it wrong? My daughter told me that the teacher was teaching a class and asked if the students knew the relationship between the rains and the seasons, when my daughter answered that Saint Joseph determines that it should rain in March and that is why planting occurs to have plenty at harvest. The teacher said that my daughter's answer was not wrong and continued the class explaining something else, that the rains are related to the seasons of the year, which she calls rainy seasons, due to Earth position in relation to the sun, anyway, I do not know… Now, on the test, the teacher asked the same question, and my daughter answered the same, that Saint Joseph determines that in March it should rain, and the teacher says that the answer was wrong! I do not understand! Does this teacher not know what teaching means, or how to teach?"
Question 4: If you were the teacher, what answer would you give to the mother regarding what to teach is, and how to teach?

about the broader theme that involved our research, which is, teacher training for interculturality in science education. We support the arguments of Reis (2012), that narratives enable the organization of knowledge by sharing and interpreting experiences. In the **third**

stage, we delivered the narratives to each teacher, so that they carried out their validations, whether they agreed or not with our interpretations.

Finally, the **fourth stage**, when we explored each narrative and generated thematic categories (Bardin, 1977). For this, we considered the lexicon, that is, the set of words belonging to the Portuguese language that is typical of the Brazilian Northeast, and the semantic—which constituted the meanings of these words in this region. Thus, the categories emerged from the meanings of the words contained in the constructed narratives, considering their most relevant characteristics for a better understanding of our unit of analysis, which were the participating teachers' conceptions about teaching Western sciences (objective and method) to students from traditional communities. In this sense, we sought that the categories of each teacher were unique and objective, without repetition of content between them.

About the categories generated in each narrative, we proceeded with the discussion, comparing the data in the light of the literature on science education. It was identified on the teachers' conceptions, the characteristics inherent to the four epistemic positions about science teaching and cultural diversity punctuated by Molina-Andrade et al. (2014), namely, (1) Universalism; (2) Multiculturalism; (3) Epistemic Pluralism; and (4) Interculturalism. We justify the choice of these positions because we understand that they can indicate the theories that teachers have about Western science, with the objective of teaching them, judging them to be relevant, or not, to establish relationships with other ways of knowing, indicating methods for this to happen.

Coherence, Consistency, and Validity of the Research

We followed the position of Molina-Andrade (2012), who divides the criteria of methodological conditions into two stages, to confirm the research coherence, consistency, and validity:

Stage 1: Construction of narratives and analysis. ***Persuasion***, because we paid attention to the consistency and plausibility of the text, explaining the theoretical support and data analysis in order to convince the reader of the steps followed; ***Cohesion***, we established relationships between the aspects punctuated in the narratives, guaranteeing their interpretation in the light of our objectives; ***Correspondence***, we explained that the constructed categories are supported by the statements of the narratives to approve the interpretations; ***Pragmatic use***, we presented contents in the narratives that can serve as a starting point for an investigation with larger samples and in other communities; ***Relationships among peers***, we carried out the research with a group of teachers who work at the same school; ***To avoid dogmatism***, we sought to build narratives with several subjects and not just one (teachers); ***Peer analysis***, we analyzed data in a collaborative way, between the participating researchers and teachers; ***Personal thinking***, we paid attention to the wealth of knowledge present in each narrative; it is part of collections shared by communities in the same world and not a matter of simple confidences.

Stage 2: Semantic content. ***Prediction or assumption***, we presented our intentions to the participating teachers in advance; ***Aesthetic value***, we presented aesthetic intentions through adjectives; ***Moral expression***, we justified the appropriation of our actions by the ethical principles of research involving human beings in Brazil; ***Emotional expression***, we revealed the emotions provoked in the participating teachers; ***Formulation of concepts***, the properties of objects were determined with adjectives; the categories were formulated by nouns and natural processes and relationships took place from verbs and adverbs;

Criticality, we were concerned with taking a critical attitude towards the problems presented by the teachers.

Results and Discussion

Given the short space available to a paper, we will present the results obtained with two (teacher Denia and teacher Maria) of the four interviewed teachers ($N=2$). In both cases, highlighted are the main categories in which their conceptions were organized, and where the epistemic positions are taken. The criterion for choosing our sample was because we considered a greater engagement of these two teachers during the interviews, demonstrating in-depth reflections on the relationships between their theories and practices.

Conceptions of Teacher Denia About the Importance of Teaching and How to Teach Western Science

Teacher Denia's conceptions about the importance and how to teach Western science to students from traditional communities were organized into 6 thematic categories, which were arranged in the four epistemic positions indicated by Molina-Andrade et al. (2014), as shown in Fig. 1. Epistemological Pluralism and Interculturalism are predominant (present in 5 categories each), followed by Multiculturalism and Universalism (present in 2 categories each).

Category 1: Scientific Knowledge to Complement Traditional Knowledge; Traditional Knowledge as Superior to Scientific Knowledge and Reflections on the Pedagogical Practice Itself

In this category, we find arguments inherent to **Epistemological Pluralism** and **Interculturalism**, as Denia argued that "[…] it is very common, for example, to come to a student and talk about issues even related to health […]," because she believes that the biology

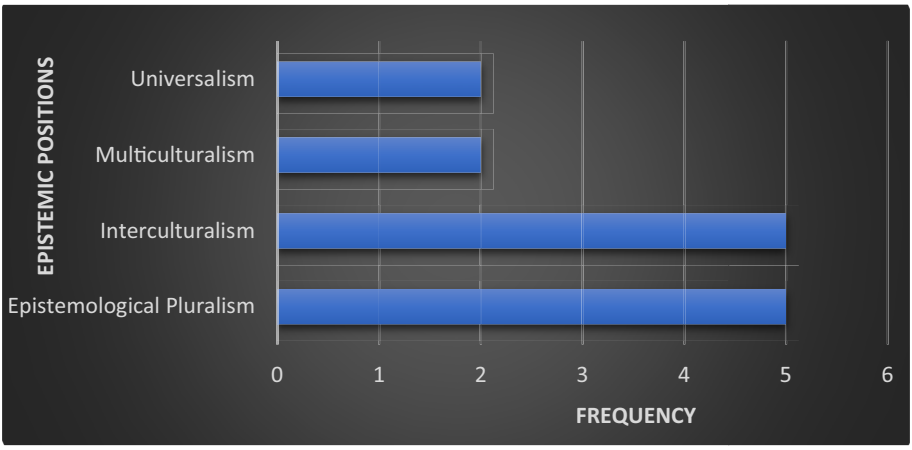

Fig. 1 Epistemic positions of teacher Denia's conceptions by thematic categories. Source: Research results

teacher has appropriate answers. However, she always alerts to the importance of going to the "[…] health center, […] going to the doctor and […] seeking a diagnosis within his community […] of some substance or medicinal plant […]."

Denia recognizes the relevance of scientific and traditional knowledge to treat diseases within traditional communities but presented arguments that suggest a position close to **Universalism**, when she narrated a situation in which she heard a student presenting his knowledge about local agriculture and her reflections on the way she teaches made her conceive that her students, "[…] have much more knowledge than the teacher." Denia argued that her reflection was based on the student's explanations and the fact that one student said, "See teacher? if these things fell on the test, I wouldn't have lost it." Denia continued her narrative saying that "[…] at that moment, I thought that everything I taught up to that day may have been very little used by most of those students, who had an extremely interesting experience, an extremely rich content, but I never gave any opening […]."

Our interpretation leads us to infer that it is not appropriate for scientific education that intends to be intercultural to have a Universalist position in face of any way of knowing, whether scientific knowledge or traditional knowledge. This promotes hierarchies that difficult students to understand adequate scientific knowledge, or even risk of reject traditional knowledge itself (Baptista, 2010). In the case of traditional agricultural knowledge, it is necessary to consider that it is the result of experiences with local agriculture and social relationships with family members and other community members. They are knowledges that differ epistemologically from the knowledge of Western science that is worked in schools, with its own origin, way, and trajectory of construction, renovation, transmission, and applicability, among other aspects.

A teacher training sensitive to cultural diversity needs to allow dialogue between teachers and students. This means a teacher training that is attentive to the countless meanings attributed to the natural world by the subjects and that is effective, among other practices, into the investigation and understanding of students' cultural knowledge, and how they relate to science (Baptista, 2015). Denia showed to reflect on her own pedagogical practice and how it interferes in the domain of science by students from traditional communities. This is certainly an indicator that she is concerned about her education, that she respects and considers the cultural universes of students from traditional communities. A scientific education that guarantees, through dialogue, equal opportunities for participation, for exposing each one's own knowledge and interests related to sociocultural issues, including scientific ones, that can avoid feelings of isolation, repulsion for science or traditional knowledge, strengthening intercultural awareness and professional teaching ethics (Baptista, 2010).

Category 2: Consider Epistemic Diversity, Interrelate Them in Classrooms, and Prepare for National Universities Admission Test[1]

After acknowledging that there was no opening for students to present their cultural knowledge in classrooms, Denia said that "[…] I would try to bring this knowledge from them […] Not only from that specific student, but […] of all those students there, of all the

[1] The National High School Exam (ENEM) is mandatory in Brazil to obtain the score required by public universities, with no taxes or tuition fees. The only way for many families to guarantee access to higher education.

knowledge they bring, and I would try to associate that with scientific knowledge." Teacher Denia's speeches seem to be positioned in **Epistemological Pluralism** and **Interculturalism**, as she recognizes the epistemic diversity of classrooms and the need to relate them to give meaning to the teaching contents.

However, Denia is positioned in **Universalism**, as she admits that she and her colleagues work "[…] a lot on a standard, a classic content-based idea of subjects that is practically determined because many students will take national universities admission tests, so they need that content […]." According to Denia, this leaves her "[…] confused […]. What am I going to teach? […] we cannot fail to give some contents because these contents are relevant to another reality that most people embrace today […]." This insecurity indicates the existence of a dilemma between teachers' conceptions and their pedagogical practices, meaning that they recognize the importance of considering traditional agricultural knowledge relating them to scientific knowledge. However, it ends up exercising a transmissive and content pedagogical practice, that does not open spaces for dialogical relationships.

For Tardif (2012), the experience of dilemmas is something frequent into the teaching profession, as the knowledge of teachers is social and at the same time personal and interferes with their pedagogical practices. On the social plane, there are considered the teacher's relationships in the school contexts where they work; at the personal level, we need to consider their mental processes, as individuals, their life stories, perceptions, emotional factors, etc. Tardif (2012) argues that teachers can act with different conceptions and pedagogical practices, as they have multiple reasons, depending on the school context in which they are inserted and the demands and needs that are attributed to them.

We agree with Denia that it is possible for the teacher to seek associations between scientific knowledge and the knowledge of the cultures of farmer students. Even though the school determines that the knowledge that constitutes the contents to be worked on in science classrooms is the knowledge that comes from Western science. As Southerland (2000) well argues, what is problematic for the teaching of science does not follow from the fact that science curricula are formed only by Western science, but rather by scientism, which does not allow the interaction of school scientific knowledge with other ways of knowing nature. However, we disagree with Denia's doubt about what to teach in science classes, whether scientific or traditional knowledge. We agree with the arguments of El-Hani and Mortimer (2007), that teachers can teach science considering students' worldviews, but without losing sight of the need to encourage them to master science. Denia could not feel "confused" if she abandons the universalist position and assumes Epistemological Pluralism and Interculturalism, which will give confidence to her in recognizing her objective of teaching Western science, particularly scientific knowledge to schools, in a dialogical way with the other cultures, with no need of hierarchies or exclusions in classrooms (Melo-Brito, 2020; Robles-Piñeros et al., 2020).

Category 3: Scientific Literacy Through Dialogic Expositions

According to Denia, it is important to teach science to help students in scientific literacy "[…] to understand […] the issues that will be important for a future national university admission test […]." For this to happen, she considers the expository class as an important strategy, however, in a dialogical way. Denia explained that when she worked with ecological relationships, she addressed "[…] inter and intraspecific relationships […]" and that she opened spaces for students to present their knowledge, "[…] to search into their community those ecological relationships […] where they could relate those contents […]

that's it, so within your community where do you perceive this society?" This conception of scientific literacy is consistent with the literature of science education and definitions contained in official public policy documents, particularly in the BNCC, or Brazilian Common National Curriculum Base (Brasil, 2017; Santos, 2007), which converge with the premise that a scientifically literate individual is capable of reading, understanding, and scientifically interpreting the natural, social, and technological world. Denia points out the need to understand scientific knowledge for application in a specific context of use, which is the Brazilian national universities admission test.

Denia once again takes a stand between **Epistemological Pluralism** and **Interculturalism**, conceiving as necessary the scientific literacy and to consider students' traditional knowledge. However, Denia takes relativist arguments that are inherent to **Multiculturalism** that is not interesting for a scientific education that promotes intercultural dialogue, when she said it is important to learn science because "[…] everything they experience from the time they wake up until the time that they go to sleep, each stage of their life is science, science is inserted there." According to Aikenhead (2002), Western science is a culture made up of subcultures that investigate and produce knowledge about nature and its phenomena through methods that are particular to them, differing from other ways of knowing in various aspects, including the discovery of "universal laws." The knowledge produced by traditional communities, although also dealing with the natural world, involves the spiritual, making no distinction between the empirical and the sacred, being strongly localized and not concerned with universalization (Mazzocchi, 2006).

Category 4: Contextualize Teaching Content Only in the Realities of Students

Although in Category 2, Denia conceived the contextualization in different cultural realities, when she was asked about which themes would be important for contextualization in classes (Table 1), she only pointed out those that she considers to be inherent to the cultural environments of students, such as "[…] the waste management […] they report the issue of the dump ground that is there at open sky […] the garbage truck comes from Coração de Maria, leaves it there on the stretch of the Retiro, people live there, they collect there, there are children who live there […]."

When asked if the other themes could be contextualized in the classroom, Denia replied that teaching about "[…] global warming, earthquakes, could be a field of geography teachers, we also talk a little bit, but I confess that I, I in the field of biology, I don't, I don't go much into those issues […]."

This answer reinforces our finding in Category 2 that Teacher Denia's conceptions have dilemmas, which may signify her position in relation to **Multiculturalism**, as she conceives contextualization in different cultural realities and, at the same time, only in the students' sociocultural environments. It is possible that Denia is not clear about the meaning of Western science and the term contextualization, particularly when she indicates that issues not experienced by students, which are not in the domain of biology, she understands that they should be addressed by other areas of school knowledge, as in the case of earthquakes by geography teachers.

Kato and Kawasaki (2011) argue that many teachers conceive the term contextualization only as the action of relating school knowledge to students' daily lives. However, this way of contextualizing leaves out the opportunity to situate scientific knowledge in the historical field that gave rise to and the understanding of science as a human and social enterprise

(Veloso et al., 2011). The contextualization of contents can be directed both to the sociocultural environment of the students and to the sociocultural environment of science itself (Kato & Kawasaki, 2011).

To consider the cultural diversity of classrooms requires thinking about the different ways of explaining nature, which includes, in addition to the knowledge of traditional communities, knowledge of the various fields that make up Western science as a cultural activity of scientists. These fields were constituted and consolidated from the seventeenth century in Europe (Aikenhead, 2002), expanding to the rest of the world through colonization, which tried to nullify all knowledge and practices of colonized peoples (Toledo & Barrera-Bassols, 2008).

Contextualization in intercultural science teaching needs to be directed not only to the sociocultural environments of the students, but also to science itself, in an interdisciplinary perspective between the different areas that make up the school curricula, avoiding fragmentation of thematic content. In addition, students will be able to understand that explanations about the natural world are not under a single domain, not even within Western science, which has subdivisions, fields that can make connections with each other, having different applicability, for example, taking universities admission tests, reading, and interpreting scientific news in specialized magazines and newspapers. If this is not possible, the teacher can work in classes with the transdisciplinarity, seeking to break the boundaries between disciplines, when they promote the understanding of natural phenomena from a plurality of explanations that will vary between different cultures and areas of schools' knowledge (Ricardo, 2005).

In the case of science teaching to students from traditional communities, many scientific knowledges worked in classrooms are totally different from traditional knowledge, therefore foreign to students (Aikenhead, 2002). Although scientific and traditional knowledge may be focused on the same elements and natural phenomena, during dialogical relationships, it is possible that different explanations occur for the same themes being studied. The teacher needs to negotiate the meanings, contexts of origin, and of applicability of Western science with students from traditional communities. For example, when working on the subject "rains," teachers could bring explanations for farmer students linked to "Saint Joseph" as a determinant of rainy periods (Baptista, 2007), in addition to Western science, which will provide an explanation focused on the seasons and the position of the Earth in relation to the sun. Scientific explanations do not involve spiritual aspects of human experiences (Cobern & Loving, 2001).

Category 5: Communicate Scientific Knowledge and Manage Conflicts

Teacher Denia assumes the **Epistemological Pluralism**, as she recognizes the existence of cultural differences in classrooms and the importance of relating scientific to traditional knowledge, avoiding confusion between these different knowledges by paying attention to the discourse itself. She also assumes **Interculturalism**, when recognizes the possibility of conflicts between scientific and religious knowledge, as well as the need to seek the negotiation of different cultural meanings. For Denia, one of the themes "[…] most difficult to work on is the origin of life […]," because many students think that teaching science will lead them to change their beliefs. Denia said that once, during her class on the origin of life, a student told her: "God forbid! am I going to stop believing in God and then be excommunicated in hell?" Then, she drew a board on the blackboard and, provoking the students' speeches, she placed the arguments: on

one side those with a scientific basis and on the other side non-scientific explanations, related to the students' religions. According to Denia, she started her first questions on how the first cells appeared, passing to living beings, including human beings.

According to Denia, the teacher needs to "[…] teach in contexts […]" communicating to students how science works, its methods, stages, but that this does not mean taking the student to "[…] believe in one or the other […]," but "[…] yes, to know different ways of thinking about that subject […]." This path adopted by Denia helps students to master science and to negotiate meanings in view of students' cultural knowledge, which for Robles-Piñeros et al. (2020) is consistent with the perspective of intercultural education, which values dialogue and management of tensions and conflicts between different ways of knowing.

Category 6: Contribute to Teacher Training Sensitive to the Students' Cultural Diversity

According to Denia, "Teaching is trying to make this relationship between what science brings […]. From academic information […] their work, their studies and make a list of what they can bring […]." For this, Denia points out how important it is for the teacher to include the relationships between the different epistemologies in teacher education, a concern inherent to **Epistemological Pluralism** and **Interculturalism** in the field of science education. According to Denia, she only had "[…] contact with practice education in schools at the end of my course in two internship subjects, which were even carried out through a one-week mini-course at the school… In other words, I basically graduated without the smallest notion of the reality of everyday life in a classroom."

The fact that Denia had no prior approaches to teach with classrooms realities and science teaching in traditional communities constitutes a bad aspect for her training process. Denia said a "[…] contact between university and school would have been important for my training and performance in teaching […] this contact in a more substantial way, tends to enrich both the undergraduate students […] and the teachers and students at the elementary school who would receive an injection of educational vitality […]." Denia said that she feels "[…] reinvigorated at every contact with undergraduate students who come to do internships, and/or research and who bring with them […] possibilities of teaching practices that tend to favor the teaching and learning process." Closer and more lasting approximations between universities and schools allow collaborative work to improve ways of promoting intercultural dialogue and removing cultural barriers, with the participation of everyone, researchers, teachers, future teachers, and students (Baptista, 2014).

Conceptions of Teacher Maria About the Importance of Teaching and How to Teach Western Science

Teacher Maria's conceptions were organized into 5 thematic categories, which were in three epistemic positions indicated by Molina-Andrade et al. (2014), as shown in Fig. 2. There predominates the Epistemological Pluralism (in 5 categories) and Interculturalism (in 4 categories) and Universalism (in 1 category). Arguments from Multiculturalism were not found in Maria's conceptions.

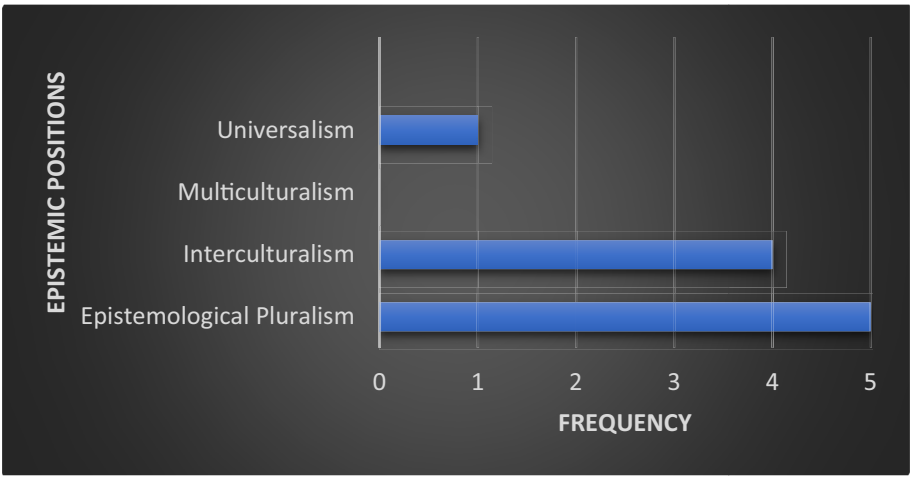

Fig. 2 Epistemic positions of teacher Maria's conceptions by thematic categories. Source: Research results

Category 1: Complement Traditional Knowledge with Scientific Knowledge

For the first situation (Table 1), teacher Maria replied that she would recommend students to seek medical assistance at health centers, but also that she would plan a class trying to find out if her students use chemicals in the community and invite their families to a meeting and dialogue about "[…] how they could use these pesticides and […] return to using knowledge of their elders, of their ancestors that is… making them return to agriculture and subsistence using […] the fertilizers […]." Maria argued that this meeting with family members would help students in the perception of what would be "[…] the benefits and harms of the use of pesticides and biological control, opening space for the rescue of ancestral knowledge […]."

Melo-Brito et al. (2019), who carried out a study with the Wayuu indigenous community, at the Guajira, Colombia, indicate that when teachers seek representations of students' traditional knowledge in their communities contributes to the appreciation and conservation of this knowledge, that is being lost over the years. We believe that teacher Maria takes the positions of **Interculturalism** and **Epistemological Pluralism**, as she recognizes the existence of scientific and traditional knowledge regarding the use of products for soil fertilization, combating "agricultural pests" and the need to relate them.

However, Maria, as well as Denia, highlights that it is difficult to teach dialogically because "[…] many [educational] parameters that come from authorities, the books that come from the [Brazilian] South and Southeast, and forget the reality of people, of the Northeast, of the people themselves who work in the countryside, who live in the countryside […]," being necessary, by curricular determination, to comply with all the contents. For Maria, it is regrettable to see how people of agricultural communities are failing to pay attention to the countryside and how the school is not contributing to the enhancement of cultural identities. Maria cited as evidence the fact that many families "[…] are not producing their own food to eat, they come to the big urban centers to buy food they don't even know where they come from […]." However, Maria acknowledged that some students and

their families still maintain their traditions and "[…] cultivate corn and beans with fertilizer made from cow, pig and chicken feces" and that she knows "how important it is to motivate them to give continuity to their cultural practices […]."

We consider this concern of teacher Maria as extremely important for an intercultural scientific education, in the sense of promoting dialogical relationships with young people. This way, they realize how important their knowledge and practices of their ancestors' traditions are, which can be considered for expansion with the scientific explanations. For example, in the case of human food, the dialogue may involve questions about the need to seek industrialized food in large cities and its relationship with the low agricultural productivity in the region, including convergences and divergences about the use of chemical products to fertilize the soil and what decisions could be taken by communities in this regard.

To Mortimer (1996), dialogic teaching becomes essentially important for subjects to be able to expand their conceptual profiles, increasing their criticality and decision-making. In this way, there will be no rejection of local knowledge because of a supposed superiority of scientific knowledge, nor of scientific knowledge, because it seems strange and meaningless to them. Students will be able to understand that scientific knowledge, as currently named, comes from a knowledge production system (Western science) that since its emergence in Europe in seventeenth century has contributed to the solution of major issues experienced by humanity, for example, in the field of health, in combating many diseases caused by bacteria in traditional indigenous communities with penicillin (Brasil, 2004). Likewise, many traditional communities have been contributing to scientific advances, for example, in the fields of pharmacology, engineering, and biology (Toledo & Barrera-Bassols, 2008).

Category 2: Educate for Country Life Through Projects Focused on the Local Reality

For Maria, it is necessary to establish relationships between science and the cultures of students who are farmers to give contextual meanings and motivate their interests in science and the countryside, because many "[…] lost that sensitivity, lost their taste by land […] they leave there and go to other states here in Brazil […]." In addition, many teachers who are not from the region "[…] follow the parameters that come from up, the books that come from there, from the South and Southeast region and forget the reality of the people, the Northeast, the people themselves who work in the countryside, who live in the countryside […]." For Maria, it is necessary to consider that the realities of students who live in traditional communities are different from those students who live in large urban centers and need an adequate education that teaches science but values their experiences to remain in their means of origin, as foreseen by **Interculturalism** and **Epistemological Pluralism**. According to Maria, "[…] if we have only focused on the way things are produced there at the Education Ministry, we will not be able to overcome this reality […]," to avoid the exodus from the countryside, unemployment and poverty, because "[…] most students have difficulty in scientific literacy […]."

The conception presented by Maria, that scientific education needs to include the knowledge and needs of farmers to motivate their interest in science, is consistent with other studies carried out with traditional communities, such as Sommer et al. (2004), who argue the failure of Western science education excluding students' cultural knowledge from an indigenous community, leading them to lack of interest in classes and school dropout. According to these authors, in 1992, 25.4% of American Indian students, native to Alaska,

dropped out of schools, not completing their studies; however, in 2002, when teaching methods that included indigenous knowledge, the students showed themselves to be motivated, decreasing school dropout rates.

In the case of Coração de Maria, young people finish high school and leave the region because they do not feel attracted to continue living and working there like their ancestors, but later come back to the farm, because they do not have specific training to work in large cities. So, according to Maria, it is necessary to teach science through projects to motivate application of science in and/or outside the field, because "[…] it does not matter if we teach biology, but the boy doesn't know how to think scientifically […]."

According to teacher Maria, teachers need to work with projects on "[…] family farming […] also take a course related […] to the environment, agricultural technician […] ecological balance […] something related that would call their attention in the field, because if you don't have it […] they will always be leaving their places […]." Maria refers to an education for permanence, improvement, development, and enhancement of the local environment and highlighted that she promotes teaching activities involving rural and agricultural themes. In her opinion, teaching still ignores local realities because many teachers find it difficult to investigate these realities and perhaps need continuing education courses. For Maria, it is necessary for each teacher to reflect on their own practice, and it is for this reason that she, feeling the realities of students, seeks to reflect and dialogue with them to consider their knowledge, with the hope of changing science education for these young people. This is in line with what Schön (2000) advocates of the reflective teacher, as a professional who maintains a reflective bond about their action, which allows them to enter a continuous learning process in favor of improving the quality of teaching and learning.

Category 3: Contextualize the Contents Taught in Different Cultural Realities

Although Maria, like Denia, assumes the meaning of contextualizing the contents taught as being within the sociocultural environments of the students, she stressed that phenomena and scientific explanations that are not part of the realities of these young people, such as earthquakes, also need to be worked in the classroom, as can be seen on her answer below: "I didn't choose earthquake there […], but in reality, I would study, think about how to contextualize […] about the plate's tectonics, I would go to assemble something, assemble a globe there, a terrestrial globe, I would go to take the countries that have the most earthquakes there […]."

According to Maria, although public policies in Brazilian education "[…] send us the rules, but so do we… make things more flexible, like, for rural schools. What are we going to work on at the school in the countryside? Why not make it more flexible?" For Maria, the Brazilian Common National Curriculum Basis (BNCC) does not provide explicit indications of how to work each culture in the classroom, but each teacher has the role of adjusting for this to happen.

According to Maria, her concern with the education of agricultural students happens because she knows their realities. In her speech, "[…] I was born and raised practically in the rural area, but I also lived and live in the urban area, but like that, I go to Retiro to teach, I'm there in the rural area […]." The fact that teacher Maria is concerned and knows the realities of the place where she works is a positive factor for intercultural science education, as it will help students to expand their knowledge for their actions with decision-making within and outside their sociocultural realities and may include those realities strongly influenced by science and technology. According to Hernández-Barbosa (2014), training teachers to work in

traditional communities requires them to be able to communicate knowledge related to the local reality, but also national and global realities. Teachers need to be aware that they can and should contribute on students' understanding of themselves, and about the world, developing skills and abilities that respond to individual and group interests and needs, promoting otherness and peaceful coexistence (Hernández-Barbosa, 2014). Therefore, Maria assumes **Epistemological Pluralism** and **Interculturalism**.

Category 4: Communicating Scientific Knowledge Respecting Students' Beliefs and Considering True Knowledge

Like Denia, Maria presented a contradiction in her speech, as in situation 4 (Table 1), she replied that:

> [...] I would respect her daughter's beliefs and hers [the mother], but the answer [...] I would certainly consider the teaching of science, right? The teacher's mistake was not stopping to discuss, there is... **something she considers to be true**, right? I would try to respect that idea of hers, but she would leave her class with scientific explanation. Each one has a belief and especially the people from rural area who have this belief even related to Saint Joseph [...] And then **we must demystify it**, but respect there, their belief [...] I would not let them go home with doubts [...] I prefer not to leave my student with doubts [...] and if I had not discussed it, I would not even ask a question like that on the test [...].

As it is possible to notice in Maria's answer, while she considers that teaching is to communicate scientific knowledge respecting the students' beliefs, taking a stand against **Epistemological Pluralism**, she points out that it is a mistake for the teacher not to discuss "*something that she considers as truthful*" and should "*demystify.*"

Maria stated that she thinks the way the teacher conducted the class was not correct and that she would dialogue with the student respecting her belief. But also, she would explain scientifically the phenomenon of rains and would ask her for a scientific answer on the day of the written test, as she would elaborate a question clearly scientific, because the class is science. For Maria, the teacher made a mistake by not making it clear what kind of knowledge she expected in the student's response in her written test.

The problem identified in teacher Maria's speech is the possibility of her implicitly conceiving scientific knowledge as true, something inherent to **Universalism**, which considers Western science as the only source of valid knowledge, discriminating and nullifying another knowledge. For Nuñez et al. (2009), the teachers' conceptions are implicit because they are unconscious and can only be discovered if they are committed to reflections on their own pedagogical practices.

In their arguments, although they want to contextualize teaching contents to students' own agricultural realities, Maria and Denia end up emphasizing scientific contents, acting in the transmissive pedagogy, without establishing, in most cases, relationships with the cultural realities, because they are required to prepare students for university admission tests.

According to Feyerabend (2007), and Quintriqueo and Quilaqueo (2019), among other authors, it is necessary to question the concept that only Western science can produce valid knowledge, which is absolute and of universal applicability, as knowledge only has meaning within its own cultural contexts, requiring the interaction between the context of discovery and that of justification. In other words, it is necessary to question scientism, which rejects all other forms of human understanding of nature besides Western science, because

the products of science have their own contexts of origin and applicability. In the situation presented to teacher Maria, her own speech recognized that the relationship between "São Joseph" and the rains period is a student's belief, originating from the local culture. Therefore, she expressed that it would be unnecessary a dialogue about what "she considers as true," but rather, what science considers as true. It would be better to negotiate cultural meanings, explaining to the student why her answer with spiritual basis is incorrect from a scientific point of view. As Cobern and Loving (2001) well argue, scientific knowledge must be understood within its own sociocultural contexts, requiring a discourse that allows its demarcation in relation to other knowledge systems.

Category 5: Improve Teacher Training Linking University and School

For Maria, teachers are unable to implement new proposals because "[…] lack of time. There are teachers who work over 40 h [a week] […] lack of qualification […] has an archaic content […] lack of encouragement from the government […]." According to Maria, the consequence is that many of her colleagues are led to see schoolwork as "palliative […] migrating to other areas and not having time to organize themselves […]."

Maria told that, even so, she continues to do her part because she likes "[…] quality, I'm always reinventing myself […] I learned to plan my classes with strength. The University does not often prepare us for this […]." In this sense, she emphasized that the university should establish closer relationships with the school to know the realities of the subjects who pass through them, the knowledge of farmer students and the knowledge of teaching. According to Maria, "Some professionals with PhD need to get off the pedestal and live the real situation, to go to the practical part […]." It is important to highlight this speech as common to teacher Denia's speech, in the sense that a closer relationship between university and school is needed. And this not only with the aim of research and initial teacher training, but as a collaborative work where all are trained as researchers, future teachers, already active teachers (from schools and universities), and students from schools.

Maria and Denia are aware that the universities where they received their undergraduate training did not provide them with theoretical and methodological support for teaching intercultural science in a traditional community, since much of their knowledge and methods used are built from their own teaching experiences and practices. In a related way, the school where they teach does not motivate them to develop new paths, especially due to curricular issues and compliance with excessive contents that are required in university admission tests, in addition to the lack of appropriate teaching resources. However, it was interesting to note that these teachers recognize the need for reflection on their own practice in order to consider the realities and cultural environments of agricultural students, requiring their own efforts, regardless of the determinations of public policies.

These conceptions of teacher Maria are positioned in **Epistemological Pluralism** and **Interculturalism**, recognizing the epistemic diversity that circulates in schools, universities, communities, and possibilities for dialogue between them. Particularly when Maria argued that universities need to understand that it is not possible to work only with theories in teacher education, it is necessary to unite practice, school routines, pedagogical practices, and the daily lives of students. A slow, complex, and continuous process, but which increases the possibilities for teachers to work the contents in a creative and interactive way with the realities of students, which may awaken their interests, since "[…] they no longer tolerate expository classes on blackboards and slides, leading them, in most cases, to sleep during classes."

Implications for Teacher Education and Science Teaching

In general, for the teachers involved in our research, teaching Western science to students from traditional communities is important for scientific literacy. This will assist them in their active participation in different sociocultural environments, having a dialogue with their cultures as the way to make this happen. In particular, the intercultural dialogue between knowledges, that is, from the culture of Western science, which are teaching contents/subjects, to the knowledge from students' cultures, from their traditional agricultural communities.

The teachers demonstrated awareness of their responsibilities to teach science; however, we found contradictions in their responses indicating that their conceptions transit in the four epistemic positions on science teaching and cultural diversity: Epistemological Pluralism, Interculturalism, Multiculturalism, and Universalism, being the first two, most emphasized. This reveals a dilemma between what they conceive as objectives and necessary methods for teaching science to students from traditional communities and what they practice at the school where they work, which, possibly influenced by public policies, conceives and determines as scientific pedagogy in schools.

We consider that these epistemic positions of teachers have profound implications for teacher education, given the objective of teaching Western science to traditional agricultural communities and the relationships it can establish with the students' cultures in these communities. Teachers can lead students to an overvaluation of Western science about their cultures or to a lack of interest in science and overvaluation of their cultural knowledge, or even to the hybridization of scientific and traditional knowledge. All this culminating in the students' inability to reflect and make adequate decisions in specific contexts and situations in which scientific and/or traditional knowledge is requested or adequate.

We recommend initiatives and promotions for science teacher education based on intercultural dialogue between the academic culture of science teacher education, school cultures, and student cultures, understanding them as sets of knowledge, symbols, and meanings that allow social interactions in school spaces. This can play a key role in science teaching in traditional communities, as it will contribute first in the implicit theories of teachers, and then, or simultaneously, in the development of new intercultural skills and abilities in these professionals. In creating teaching strategies in substitution to the transmissive pedagogy, which assumes the positions of Universalism and scientism, and the relativist pedagogy of Multiculturalism, which assumes that all knowledge systems have the same values and applicability contexts.

We understand that training teachers to teach in a culturally sensitive way is an important challenge for undergraduate courses, not just for the school contexts of traditional communities. All classrooms, in all schools, are multicultural spaces and, therefore, university professors need to pay direct attention to people's multiplicity of worldviews. This requires a pedagogical practice based on dialogue and being able to practice it, in the sense of investigating and monitoring the realities and interests of subjects in Western science. If so, teachers can plan with objectives based on the relationship between theory and practice.

The teacher needs to live experiences from their initial training, requiring closer partnerships between university, school, and community, of investigation and reflection on the school realities and the individuals who move through them. This will help in their own training, in feeling prepared for interactions, considering that not all teachers who will work in schools located in traditional communities, or who serve students from these communities, come from these communities, and know their cultures and languages.

As professors of future science teachers, we have experience at universities in Brazil and Colombia. Our work with undergraduates seeks a proximity to school realities of future teachers. The strategies are varied and include visits and interviews with subjects from traditional communities. Coordination of schools-university partnership, moving classes within university spaces involving students from agricultural and indigenous communities. Also, on the construction of didactic resources and sequences that promote relationships between traditional and scientific knowledge, including the natural resources surrounding these communities, to problematize realities experienced by teachers from traditional communities and the confrontations with literature in the field of science education, among others.

We intend to continue the research reported herein. Our next step will be the development of a new survey, with a significant number of representatives within the multicultural universe that is present in schools that serve students from traditional communities in Latin America. The objective is to generate broader data that will contribute to the elaboration of a training model for science teachers to work in schools that serve students from traditional communities based on intercultural dialogue and the relationship between universities and schools.

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