ACTA SCIENTIAE

ISSN: 2178-7727
DOI: 10.17648/acta.scientiae.6852

Science Education and Indigenous Knowledge in a Decolonial Perspective: An Argentine Case

Tatiana Edith Vergara [a]
Veronica Albanese [b]

[a] Universidad Nacional del Chaco Austral, 3700 Presidencia Roque Sáenz Peña, Chaco, Argentina
[b] Universidad de Granada, Departamento de Didáctica de la Matemática, 52005, Melilla, España.

ABSTRACT

Background: In the context of Intercultural Bilingual Education, various explanations of natural phenomena circulate. **Objectives:** We wonder how such diversity is addressed in science classrooms taking into account the intercultural and decolonial approaches proposed by the Epistemology of the South. The objective of this research is to explore the relationships between a teacher's curricular decisions, their conceptions about the nature of science and indigenous knowledge, and their students' conceptions about the nature of science and indigenous knowledge. **Design:** A qualitative and exploratory research is carried out, as a previous diagnosis for an action-research. **Setting and Participants**: The case study is a natural sciences course in a Bilingual Intercultural Education Teacher Training Program in Argentina; the participants were the teacher who teaches the course and his 15 students. **Data collection and analysis:** Data are collected through non-participant observation, and interviews and content analysis are performed with categories defined a priori from the literature. **Results:** There is a great difference with respect to the activities proposed for the topics on scientific knowledge and that on indigenous knowledge, which reflects the teacher's conceptions. There is a lack of dialogue between the knowledge approached, as well as a lack of reflection on the problems that arise. The students' conceptions reflect these tensions. **Conclusions:** This suggests rethinking the teaching of science in the context of the intercultural modality in order to reverse the hegemonic role that scientific knowledge continues to play.

Keywords: Science education; Conceptions; Interculturality; Decolonization; Teacher education.

Corresponding author: Veronica Albanese. Email: vealbanese@ugr.es

INTRODUCTION

This research arises from an interest in science teaching models in the pre-service training of teachers who will work in multicultural environments. We are moved by concerns about what happens in the classroom when conceptions about natural reality come into play that may differ widely, in this case, the scientific and indigenous views of natural phenomena. Other research (Boisselle, 2016; Higgins, 2016) has highlighted that such differences can be revealed as a source of tension. Santos (2013), the theorising then epistemic colonisation of the South of the World, makes visible the inability of current educational systems to recognise different forms of knowledge, marginalising local and indigenous knowledge towards a global uniformitarian model, even in the experiences of Intercultural Bilingual Education (EIB), where, in some cases, the focus is mainly on the linguistic translation of Western knowledge (López, 2014). Santos (2013) claims the need to act processes of decolonisation of knowledge, looking at the scope of cognitive justice, a key element of social justice, also promoting the integration of worldviews, knowledge, values, cultures and practices of indigenous peoples (OEA, 2016, p. 6).

Here, we propose investigating how, in the training of pre-service indigenous teachers, the tensions arising from the presence of different conceptions of natural facts are addressed and how the teacher reacts in response to them. The interest is to carry out and present a first diagnostic phase of a classroom action-research process that is still in progress.

The general objective of the research is to establish relationships between curricular decisions and conceptions regarding scientific knowledge in school (SKS) and traditional ecological knowledge (TEK) or indigenous knowledge of the teacher/trainer and the students/future teachers. It was decided to work in a Higher Education Institute located in the city of Presidencia Roque Sáenz Peña, province of Chaco, Argentina. This Institute offers a Bilingual Intercultural Teacher Training Program for Primary Education for students (pre-service teachers) coming from indigenous peoples and will develop their future teaching work in indigenous environments.

We define the following specific objectives:

1. To characterise the curricular decisions (at the level of contents and teaching methodology) made by the teacher of the Natural Sciences subject of the above-mentioned Teacher eTraining Program.
2. Identify the conceptions about the nature of school scientific knowledge (NoSKS) and the nature of indigenous knowledge (NoTEK) stated by the subject teacher.
3. Identify the conceptions about NoSKS and NoTEK declared by the students of the subject.

We will see how the theoretical framework of reference, the Ecology of Knowledge (Santos, 2013) -a crucial concept of the Epistemology of the South- offers us the starting point to analyse the tensions present in the teaching of science in the Intercultural Bilingual Education (EIB) modality.

Context

At present, the province of Chaco hosts a rich cultural diversity with the presence of several native peoples, including the Qom, Wichí and Mocoví/Moqoit. The 3.9% of the province's population is recognised as indigenous, around 41,000 people. Of these, 95.1% are from the three indigenous peoples mentioned above, native to the Chaco (INDEC, 2010). This means that the province has a very heterogeneous linguistic and cultural reality. At the linguistic level, part of the communities of the native peoples communicates through their mother tongues, others partially use Spanish, and others adopt Spanish as their primary language.

In relation to the educational aspect, the province of Chaco has been the scene of very significant bilingual intercultural educational experiences since 1987 (sanction of provincial Law Nº3258 "On indigenous communities"). However, the focus of interest has always been more on bilingualism than on interculturality in the broad sense, as we will explain below.

RELEVANCE AND LITERATURE REVIEW

Interculturality and the ecology of knowledge

Interculturality is a concept that is constantly under construction. Here we provide an overview of the richness of this concept.

Colonisation, which took place in the 15th-16th century with the arrival of Christopher Columbus, has generated, among many other dynamics of domination, the installation of the Western-centric paradigm (Estermann, 2014). A particular

culture was imposed as universal against other cultures, generating the latter's exclusion in all aspects of society (customs, knowledge, values, practices, among others).

At the end of the 20th century, decolonising movements characterised different areas in Latin America. Their interest lies in reversing the tendency to impose those ways of knowing - and living - that were generally imposed by Eurocentrism (Mignolo, 2010). This demand consists of a deconstruction-reconstruction-construction of politics, institutions, economy and society based on other thoughts, epistemologies and ways of understanding reality. In this context, interculturality is established as a paradigm that seeks to revitalise contacts between different cultures, often conflictive, in order to achieve a plurality of voices and visions. In Latin America, the use of this concept has focused on indigenous issues, particularly in the relations between these groups and organisations, institutions and agencies characterised as dominant (Mato, 2009). By recognising and valuing cultural differences through dialogue, it is hoped that more honest and equitable societies will be built (Mato, 2009), i.e., socially fairer.

Interculturality entails recognising, in the encounters and contacts between different cultural agents, certain tensions and relations of domination of some over others, but also the need to generate actions that allow for the reversal of such a situation (López, 2014).

As a theoretical pillar, the ecology of knowledge pursues the need to make knowledge from different cultures visible, shedding light on alternative practices to enable their coexistence through intercultural dialogue. Santos (2010, 2013) proposes the need for a new look at knowledge (fundamentally scientific) and the legitimisation of the ways of knowing forgotten and oppressed peoples by the hegemony of modern Western thought.

European colonialism has caused profound destruction of peoples' own knowledge – epistemicide – provoking the imposition of modern science as the unique criterion of truth and passing off as non-existent everything that it does not legitimise or recognise. The Epistemology of the South (Santos, 2010) seeks to establish knowledge and criteria of validity to give visibility and credibility to the cognitive practices of those social and cultural groups that were ravaged by colonialism, global capitalism and patriarchy, allowing for a reframing of the position described above between scientific knowledge, local knowledge, nature and the human being. Science is not seen as wrong, but the exclusivity of rigour attributed to it is criticised, dismissing the world's diversity. Therefore, a double theoretical-empirical work of the present and the future is respectively through the sociology of absences and the sociology of emergencies. Absences make explicit what was and is considered non-

existent (Santos, 2013): 1) monoculture of scientific knowledge, 2) logic of linear time, 3) monoculture of social classification, 4) monoculture of the universal, 5) productivist monoculture. Emergences are those possibilities and potentialities that come with absences, which can be realised in specific future actions. Within this framework, the Ecology of Knowledge is inserted: "a way of recognising and valuing the existence of a plurality of knowledge beyond scientific knowledge" (Santos, 2013, p. 183, own translation). This plurality implies speaking of an epistemological diversity in which a variety of forms of knowledge about reality is accompanied by a variety of criteria used to validate this knowledge.

Science education and cultural diversity

According to what was stated above, we wonder about the current state of science teaching with respect to multicultural classrooms, a space in which diverse positions and ideas in relation to natural phenomena and/or facts can come into tension. We highlight some background information without being exhaustive.

Molina and Mojica (2013) recognise four perspectives on teaching actions and assumptions that guide the use of bridges between scientific knowledge in schools (SKS) and traditional-ancestral knowledge known as traditional ecological knowledge (TEK):

a) Assimilationist perspective: Scientific knowledge is the protagonist in science education. TEK is reduced, assimilated or not considered at all.
b) Moral and humanist perspective: The other is recognised, trying not to discriminate against him/her for being different, but there are no concrete actions regarding the relationship between different knowledge.
c) Plural epistemic and ontological perspective: "bridges" are used to facilitate exchanges between TEK and SKS.
d) Contextual perspective: Context is assumed as a connecting bridge for the emergence of new hybrid knowledge between TEK and SKS.

In Canada, Aikenhead and Huntley (1999) investigate science teachers' views of scientific knowledge and how they introduce indigenous knowledge into their science classes. They find that teachers tend to force their students to negotiate transitions between their home culture and school science on their own. On the contrary, they suggest that indigenous students need a culture broker teacher who enables and facilitates access or bridges between their indigenous culture and Western culture.

From this study, a prolific line of research on the decolonisation of science education and the integration of indigenous knowledge in science classes has emerged, mainly in Canada (Aikenhead and Elliot, 2010; Higgins, 2016, but also in other continents - for example in Central America (Boisselle, 2016).

According to Valladares-Riberoll (2011), it is essential to build science education practices that invite to consider the diversity of existing knowledge in addition to scientific knowledge. Based on his pluralist position on knowledge (epistemological pluralism), he argues that both scientific and traditional knowledge generation have common features that make a sharp distinction between them difficult to make. Furthermore, these types of knowledge are born as a response to the needs, interests and motivations that human groups have had in the face of the adversities of the environment in which they live. However, traditional practices and knowledge are often analysed outside their context and valued according to scientific epistemological criteria, thus generating a profound devaluation of the former.

Creating a space within science education that allows for epistemological openness can challenge the extreme scientistic stance that causes students, in this case, indigenous students, to question the knowledge and wisdom that their ancestors have passed on to these generations.

In Argentina, research in science education and interculturality is a developing area.

Since 2014, the IECI Group (Intercultural Science Education Research Group) at the University of Buenos Aires has been designing materials and intervention strategies that promote cultural inclusion in multicultural classrooms in the area of experimental science education (Meinardi, 2017). Its field of action is in the provinces of Chaco and Formosa.

Dumrauf and Menegaz (2013) analyse possible facilitators and obstacles to developing intercultural didactic proposals in science by in-service teachers in the province of Jujuy. We highlight some of the most relevant obstacles: treatment of the scientific method from a non-critical school-based perspective, disjointed and anecdotal presentation of cultural practices, focus of the teaching on homogenising scientific literacy, scarce recovery of experiences and theoretical contributions of indigenous knowledge due to the lack of access to specific materials, among others.

Maimome et al. (2021), after its application in the suburbs of Buenos Aires, propose the Paradigmatic Interrelationship Model (MIP) as a didactic strategy to place different theories in tension when interpreting a specific fact or phenomenon. This model was developed for the area of environmental education but with the perspective of being applied to other disciplines as well.

THEORETICAL FRAMEWORK

Curricular decisions and conceptions

Curricular decisions are those choices, adaptations and/or curricular modifications that teachers make in order to address, in this case, the multicultural reality. The results of the teaching and learning process depend mainly on the teacher's decisions on a daily basis to achieve the objectives he/she sets for him/herself concerning what he/she wants to teach (Espínola, 1992). This research focuses on the teacher's decisions about content and activities.

Activities are interpreted as the set of tasks developed to favour the teaching-learning process, allowing the exchange and understanding of information and whose dynamics involve teacher and students. Cañal (2000) suggests the following classification for activities based on information processing: 1) activities aimed at mobilising information (students receive information), 2) activities for organising and transforming information (students manipulate information), 3) activities for expressing information elaborated by the students themselves.

We indicate with *conceptions* of the nature of knowledge what participants claim and show to believe about what that knowledge is, how and by whom it is developed or guarded, why it is used and how it is put into practice (Albanese and Perales, 2020).

Although there is no consensus in the academic community, our starting assumption is that curricular decisions are determined (Caetano and Neto, 2005) and, in turn, carry a valuational burden towards SKS and TEK; such valuation, on the one hand, constitutes one of the main factors that influence teaching, and on the other, conditions conceptions about the nature of the knowledge that circulates in the classroom.

Following this position, it is vital to study what conceptions exist in the classroom and whether they are compatible and manifested in teaching epistemic equity.

Nature of the SKS and TEK

The NoSKS is a term with diverse meanings given scientific activity's multifaceted and dynamic nature. In general, and broadly speaking, it is defined as a "meta-knowledge about science, which arises from interdisciplinary reflections from the philosophy, history and sociology of science" (Acevedo-Díaz and García-

Carmona, 2016, p. 3, own translation). We consider that this encompasses not only epistemological aspects but also historical, sociological and technological ones, which allows us to analyse scientific activity holistically - and critically - and to be able to banish its place of superiority and epistemic hegemony. These aspects generate a more authentic and coherent vision of scientific activity and its teaching-learning.

Fernández et al. (2002) define seven non-exclusive conceptions of NoSKS that usually occur in science classrooms and that effectively ignore the dimensions suggested above to deal with NoSKS:

- Empiroinductivist and atheoretical conception: gives a central role to neutral observation and experimentation. It does not consider the role of hypotheses and available theories.
- Rigid conception: conveys an algorithmic, exact, infallible view of scientific activity. The scientific method consists of a series of steps to be followed mechanically. There is no room for creativity, invention and doubt.
- Approblematic and ahistorical conception: knowledge is transmitted in a ready-made way. Facts related to its origin and evolution are suppressed.
- Analytical conception: it emphasises the systematic division into disciplines, their bounded and simplifying particularity. It does not consider the construction of coherent bodies of knowledge.
- Cumulative conception: it is a cumulative, linear vision. There is no allusion to the confrontations between theories and the complexity of the development of the processes of scientific knowledge.
- Individualistic and elitist conception: scientific knowledge is considered the work of solitary geniuses without considering the role of work teams. Scientific activity is the work of a minority, not accessible to all.
- A decontextualised, socially neutral conception: it ignores the influence of the political, economic, historical, business, social and cultural context in which scientific activity takes place. In turn, it does not take into account the personal interests and motivations of the scientists themselves.

These seven conceptions operate as absences (Santos, 2010, 2013) as they do not allow for a real interpretation of the scientific activity. Being able to identify them and transform them, going deeper into the epistemological, historical, sociological and technological aspects, would allow us to move to the decolonisation of knowledge and to propose an open ecology of knowledge, which are indispensable requirements to speak of interculturality.

But what are the characteristics of indigenous traditional knowledge (NoTEK)?

The Western vision of the world suggests that what cannot be understood directly must be denied or suppressed, just as it denies the possibility of the polyvalence of things. Although each indigenous people has its own characteristics with respect to its culture and worldview, we can offer broad features that characterise its knowledge and wisdom. In TEK, the search for harmonies and complementarities prevails in order to achieve integration in the whole, including the invisible world, giving reality a more complex reading (Martínez-Sarasola, 2010). The indigenous worldview is characterised by a totalising and integrating vision of the world, life and the universe, whose emphasis is on spirituality manifested in the celebration of ceremonies. Martínez-Sarasola (2010) summarises the indigenous worldview based on a set of central ideas common to indigenous peoples (Table 1).

Table 1

Main ideas of the indigenous worldview. Source: inspired by Martínez-Sarasola (2010).

Ideas	Description
Totality	It refers to the integrative and inclusive view of life and reality. This is manifested through complementary opposites, duality, the multiformity of the gods and the notion of circularity.
Energy	It is the life force that regulates the rhythm of the cosmos. It manifests itself at the culminating moments of life and death. It transcends matter and spirit through the fusion of both. It is the generator of creative vitality.
Communion	It refers to the deep connection, the intense contact between the indigenous person, nature and the cosmos. It is as if nature and the cosmos become flesh in man and vice versa.
Sacrality	Everyday life is loaded with small sacred acts in order to give it true meaning. The sacred is strongest in shamans.

Community Sense of Life	The collective development of life gives it meaning. While the person and the individual are respected, they acquire their fullness when they coexist in community.

According to the Regional Bureau for Education in Latin America and the Caribbean (OREALC/UNESCO, 2017), the indigenous worldview is shaped through a continuous process of interaction between living and supernatural beings through observation and experimentation. This interaction also takes place intergenerationally (between elders and young adults) so that knowledge is not the property of a single individual, but of a whole collective. In contrast to the Western vision, which sees nature as an object of control and domination by people, according to the indigenous conception, nature functions as a whole and human beings are part of it in the process of continuous relationship, harmony and balance.

Moved by an interest in investigating the situation in Argentina, we set out to carry out this exploratory research in an institute that trains future (pre-service) indigenous primary school teachers.

METHODOLOGY

This work is part of the diagnostic phase of an action-research process still in progress. For this stage, a qualitative methodology of an exploratory, descriptive and interpretative nature was selected through the case study (Stake, 1998) constituted by the subject of "Natural Sciences" taught in the second year of the Intercultural Bilingual Teacher Training Course for Primary Education mentioned in the introduction. The choice to carry out a case study is due to the interest in the particularity and complexity of the phenomenon observed in its context (Stake, 1998).

Participants

Fifteen students (future teachers), five women and 10 men, between 20-25 years of age, all indigenous from three different ethnic groups (12 Qom, 2 Wichí and 1 Mocoví/Moqoit), as well as the non-indigenous teacher of the subject, are taking part in the study. The ten students who live in the interior of Chaco Province are living in the Institute's residence. Prior verbal consent has been obtained from all of them and from the institution's management, as well as the written consent of the teacher.

An important issue to take into account is that the participating teacher starts his activities in the institution the same year in which the fieldwork of this research was carried out (2015). Therefore, he uses the planning of the previous teacher in charge to develop the subject. At the same time, he has no previous experience in this educational modality.

Instruments of data collection

The techniques used are the observation and detailed recording of classes in the field notes, semi-structured interviews with the teacher of the subject, and the students' productions during an activity proposed by the researchers. The choice of various data collection strategies has been adjusted as the fieldwork has been carried out. This situation is possible within this type of research, given that the complexity of the object of study often makes it impossible to decide "a priori" on a specific strategy (McMillan and Schumacher, 2005).

The subject has an annual duration; the recording of the 23 classes is done during the 2015 school year. Some classes are audio-recorded.

Two semi-structured interviews are conducted with the teacher to inquire –or confirm information– about his training and professional experience, his stay at the institution, the reasons for his curricular decisions, his relationships with students, and his conceptions of the NoSKS and NoTEK. These are audio-recorded and transcribed.

In addition, it is agreed with the teacher to carry out an activity related to the drawing of indigenous scientists and wise men in their usual environments to obtain evidence of the students' conceptions - such a strategy has already been used by Pujalte et al. (2014).

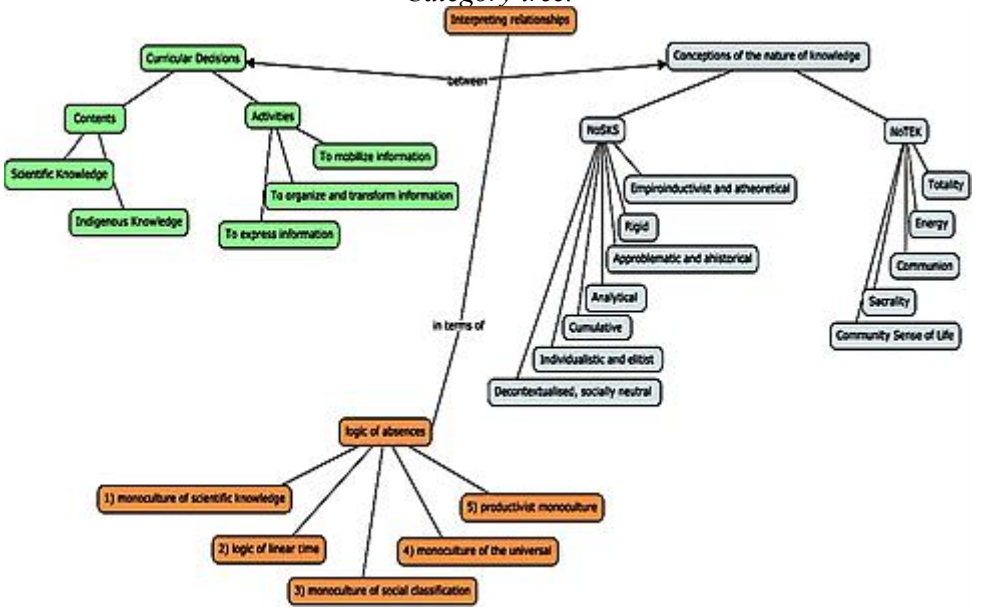
Categories and analysis

Those data that respond to the research interests are selected and, with the support of the Atlas.ti 6.0.15 software, content analysis is carried out. This is a non-intrusive technique that allows the description, organisation and understanding of texts based on the context in which they arise, facilitating subsequent interpretation (Schettini and Cortazo, 2015). Categories are defined a priori (depending on the questions and objectives of the research) (Figure 1) determined by a cyclical literature review, already described in the theoretical framework section, which has been adjusted to the data during the research process analysis: among the curricular decisions, the contents and activities are analysed (according to Cañal, 2000); among

the conceptions about NoSKS, those determined by Fernández et al. (2002) are identified, for the conceptions about the NoTEK, what is described by Martínez-Sarasola (2010) is considered.

Figure 1

Category tree.



In the discussion, the interpretation of relationships between decisions and conceptions expressed by the teacher and students is made in terms of absences (Santos, 2013).

In this way, through the multiplicity of data sources, it is possible to triangulate the information on the doing and thinking of the teacher and students and the observation of the researcher, supporting the validity (Moral, 2006) of the research as well as the analysis.

RESULTS

Some of the most significant results according to the three proposed objectives will be presented below. A description of the curricular decisions and some episodes that show the conceptions observed are presented to then interpret them.

Characterisation of curricular decisions (content and activities)

The contents developed in the subject are the following: division of the natural sciences, scientific and everyday knowledge, the scientific method, living and non-living beings, living and non-living elements, biodiversity, types of cells: eukaryotes and prokaryotes, microscope: observation of cells, kingdoms, levels of organisation, indigenous scientists and wise men, plants and medicinal plants.

Although in the planning of the subject, all the units to be developed include some topic related to the TEK, of these thirteen (13) topics addressed, aspects of the indigenous worldview (IC) are involved in only three (3): elements with life and lifeless, indigenous scientists and wise men and medicinal plants. Let us remember that the planning used by the teacher corresponds to that used by the previous teacher.

There is little or no articulation and discussion between the TEK and the, and the contents of the TEK remain undefined and unclear. This is evidenced, for example, in the theme of Elements with life and without life according to the indigenous vision: fire, earth, water and wind are elements with life for the indigenous worldview. But in the classes, the very concept of, SKS contents life is not problematic for the indigenous cosmovision? Are there concepts that refer to life in their language? What is the importance of these elements in the indigenous cosmovision? Based on this conception of life, are these elements alive? Are there these categories “alive” and “not alive” in the indigenous cosmovision? Finally, it is unclear whether these elements have life since the contradictions arising from not making explicit from what point of view life is considered are not resolved.

Further evidence of the poor articulation of TEK and SKS and of the possible tensions that would arise from such an attempt, is highlighted in this episode:

> *Teacher: One day, I said: man evolved from such [the primates], so they stared at me with a face as if to say, what are you telling me? (Transcription of interview 1).*

Regarding the same, triangulating the data, the researcher's notes state:

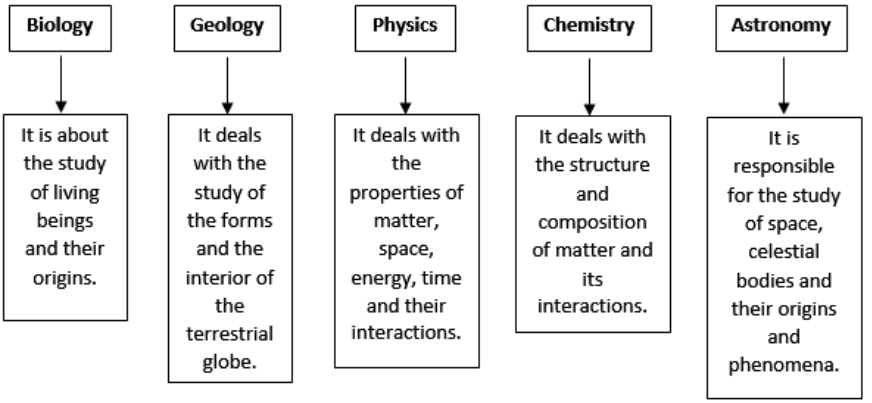
> *Students showed expressions of doubt or were silent about the teacher's position on evolution, which could be interpreted as an*

> *indication of disagreement with what the teacher was explaining (Researcher's field notes, 21/05/2015)*

With regard to activities, there is, in general, a clear predominance of activities that mobilise oral and written information, with the teacher being the main source of this information. For SKS content, the teacher mainly dictates definitions and does not propose any type of activity involving experimentation, observation, formulation and testing of hypotheses. He sometimes supports the explanations with comparative tables, concept maps, and drawings made by himself (see Figure 2).

Figure 2

Division of Natural Sciences, according to the teacher's explanation.



For topics related to TEK, the dynamic is different as the teacher proposes activities to express information provided by the students: research work, report writing and presentation of the results to classmates.

In the interviews, the teacher recognises that he has no training on the topics related to TEK; therefore, he prefers that the students provide contents:

> *Teacher: It is a strategy that sometimes we have to use when we know that they (the students) are strong in that subject, not me. (Transcription of interview 1)*

The teacher also questions whether an approach other than imposing scientific content, which he considers appropriate in other contexts, would be necessary for the intercultural modality:

> *Teacher: That was one of the things that was a bit difficult for me because you go to school and explain the scientific part and that's it, and that's how it is, and with them [indigenous students], it's not so easy to impose. (Transcription of interview 1)*

But it is when it comes to planning, the difficulty of making it happen becomes evident.

Conceptions of the nature of science and the nature of indigenous knowledge of teachers and students

Based on the given contents and activities, we analyse the teacher's conceptions of NoSKS and provide paradigmatic episodes as evidence.

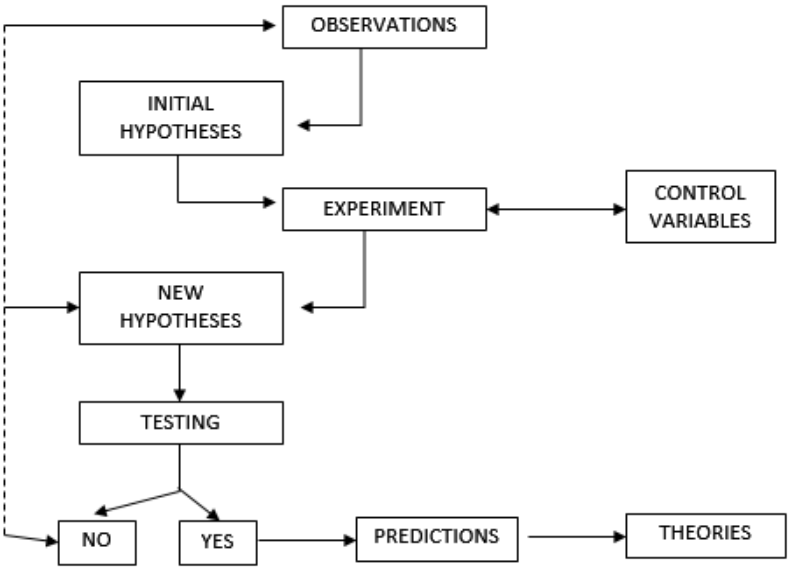
According to the evidence, the teacher reveals an analytical conception of science due to the division of science into disciplines (see figure 2).

Likewise, there are rigid traits in terms of his conception of science, which is evident in the definition he presents to the students and its relation to the description of the scientific method:

> *Science (from Latin, knowledge) is the ordered body of systematically structured knowledge. Science is the knowledge is obtained (...) by means of a scientific method (Researcher's field notes 28/05/2015).*

Figure 3

The scientific method as explained by the teacher.



In addition, Figure 3 shows the scheme proposed by the teacher for the steps of the scientific method.

We highlight the absence of aspects that can influence scientific work, whether of a personal nature (subjectivities) or external factors, thus recognising a decontextualised conception of nature.

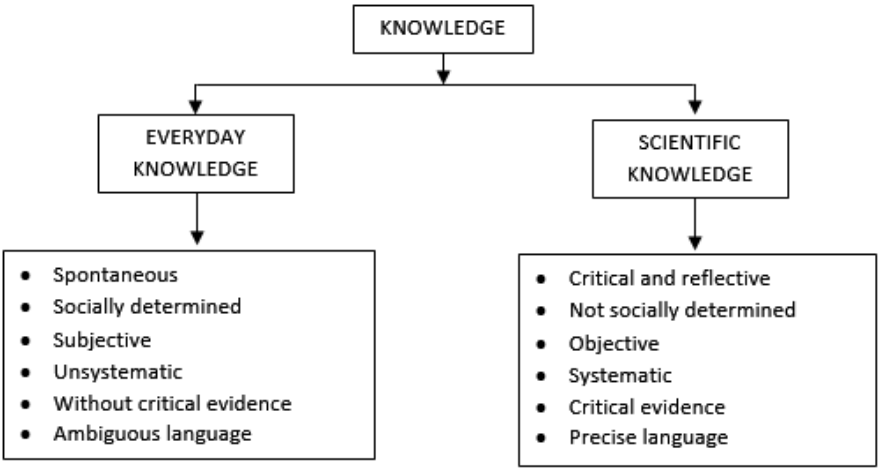
Another revealing episode concerns distinguishing between scientific knowledge and vulgar/common knowledge. The teacher labels indigenous knowledge into the latter. The definitions given in class are:

> *Scientific knowledge: it follows a process for its correct creation. Thus, the observation of what surrounds us, the argumentative criticism of the facts, and the enquiry into what makes us curious are an essential element for its creation. It is a critical approach to reality based on the scientific method (...)*
>
> *Everyday knowledge: is acquired through the actions we carry out every day, (...), doing 'things' whose fundamental objective is not the*

acquisition of knowledge but something else, (...) something is achieved 'unintentionally'. (Researcher's field notes, 02/06/2015).

Figure 4

Types of knowledge and characteristics. Diagram created by the teacher.



Finally, the teacher presents the following scheme (Figure 4).

In these definitions, characteristics of science understood as a rigid and analytical activity are reiterated. In Figure 4, SKS is defined as objective and systematic, and not socially determined, implying it is the product of an elite of people with brilliant skills and abilities, reinforcing the idea that science is not accessible to all (individualistic and elitist conception). The idea that science is the product of human construction, in which mistakes, coincidences and successes - as well as other historical and social factors influenced its evolution (an unproblematic and ahistorical conception) is also dismissed.

Likewise, during the interviews, the teacher shows flexibility tow the possibility of considering that scientific activity does not necessarily take place in the laboratory:

Teacher: Sometimes, being a scientist is not just discovering something or working in laboratories (Transcription of interview 2).

The evidence on the teacher's conceptions of NoTEK is scarcer and less explicit. During the development of the subject, we have not been able to identify the treatment of the categories suggested by Martínez-Sarasola (2010).

In Figure 4, there is some evidence of the teacher's conceptions of NoTEK. The teacher stresses that indigenous knowledge does not meet the criteria of validity determined by science, implicitly denying it the status of knowledge, attributing to it the valuation of vulgar/common knowledge. However, when evaluating the students' work on TEK, the teacher explicitly states that he only checks the wording, given the impossibility of using the criteria of the SKS, which contradicts what is expressed in figure 4. The teacher recognises that SKS and TEK are very different ways of looking at reality, and that each one should be interpreted based on its own criteria, although, on occasions, he himself uses the criteria of science to evaluate TEK.

Regarding the students' conceptions, the results of the activity of drawing a person who is dedicated to science in his work environment and an indigenous wise man (Pio'oxonaq for the Qom culture) in the environment where he usually moves (Figure 5) and, finally, mentioning the characteristics that identify these figures, stand out.

As for the scientist, similarities were observed in terms of his appearance (half-haired, with a smock, neat, male) and the predominance of solitary work, which corresponds to the individualistic conception of scientific activity. In addition, the laboratory (chemistry) predominates as a workspace, which shows a decontextualised conception of the environments in which scientific work can be carried out. In no case are there any elements that suggest external influences such as the political, social, historical and cultural context or aspects of a personal nature such as feelings, emotions, interests and the subjectivity of human beings, which reinforces a decontextualised conception.

In relation to the indigenous sage, we observe nature (fire, vegetation, etc.) as a recurrent element in the drawings, being a central aspect for the worldview of the Original Peoples. A student described:

> *Knowledge based on nature; he uses natural elements that are passed down from his ancestors; he uses everything from nature and religion to cure diseases; he does not do any study; he is guided by a spiritual gift; he is like a scientist because he also researches; power of the natural and his knowledge; powers are given by nature; he uses natural, spiritual and herbal means (Student's production, 15/10/2015).).*

The indigenous wise men or shamans (Pio'oxonaq) use herbs, animals and chants to heal people (Sánchez, 2009), an issue also taken up by the students. Their costumes are varied. Sometimes the sage appears bare-chested, sometimes clothed, with headbands and feathered headgear.

We summarise below the characteristics mentioned by the students with respect to the TEK which, according to our interpretation, seem to overcome some of the absences with respect to science and are related to the ideas proposed by Martínez-Sarasola (2010) on the indigenous cosmovision:

- Generational exchange of wisdom and powers between ancestors and current generations, indicative of a communal sense of life (overcoming an ahistorical conception).
- Energy and sacredness, in the sense of the connection between the human and the non-human as a way of explaining and conducting oneself through life, providing a role for creativity, invention (as opposed to rigid conception).
- Sense of wholeness, life as a profoundly complex system in which diverse types of beings and elements are involved (suggesting a complex and systemic conception, overcoming the simplistic and analytical conception).
- Nature as a provider of life and knowledge (overcoming the decontextualised view).

The drawings of the indigenous sages respond to certain stereotypes that have been transmitted throughout history and that are similar to diffuse representations from colonial times and not always contextualised in the Argentinean or South American geographical framework. On another occasion, we will explore this issue in greater depth.

Figure 5

Drawings of indigenous and scientific sages made by the students.

DISCUSSION

The discussion responds to the general aim of the research to establish relationships between curricular decisions and the conceptions of NoSKS and NoTEK of the teacher and students of the natural science subject under study. An interpretation with an intercultural and decolonial perspective is shown based on the observation of the data set - only partly summarised in the previous section - and on the theoretical approaches mentioned above.

Contents-activities-NoSKS- NoTEK according to the teacher

We observe that there is a correlation between the contents and activities chosen by the teacher and their conceptions of NoSKS and NoTEK. The contents proposed by the teacher are, for the most part, related to scientific knowledge.

In the activities there is a clear differentiation between SKS and TEK: for SKS, activities are proposed that mobilise information, where the teacher plays the leading role; while for TEK, the activities depend on the information elaborated by the students, who provide the contents. This responds to the limitations that the teacher himself acknowledges about his poor management of TEK by mentioning that his strategy is to resort to the students, given that they have greater knowledge of the subject. Although this openness and flexibility is of great importance for the work in this multicultural context, in relation to SKS, the teacher ends up having an aproblematic, ahistorical position: although he mentions that SKS cannot be imposed in the multicultural classroom, he does not act accordingly, there is no discussion or problematisation in relation to the contents coming from both knowledge.

This way of proceeding is consistent with the teacher's conceptions. Most of the teacher's definitions of science and scientific knowledge insist on a rigid, analytical and decontextualised conception, stressing that scientific activity is governed by a method (regardless of the scientific disciplines, it seems to be the same for all) and linear and rigid procedures (see figure 3), far from the influences of the historical, social, political and cultural context in which it arises, as well as the subjectivities, interests and motivations of the human beings who practise it; aspects highlighted by Dumrauf and Menegaz (2013) as obstacles in intercultural proposals.

The teacher's vision of TEK is limited, so he chooses activities that give the students a leading role. With regard to indigenous knowledge, the teacher suggests that it is part of the beliefs or vulgar knowledge that indigenous communities have. This situation undoubtedly has consequences with respect to what Santos (2013) mentions about absences: monoculture of knowledge (1st logic of absence), everything that modern science does not legitimise lacks value; monoculture of the universal, that which is considered to be particular or local ends up being dismissed (4th logic of absence). Features of epistemicide and the superiority of SKS over TEK are maintained.

Teacher-students' conceptions

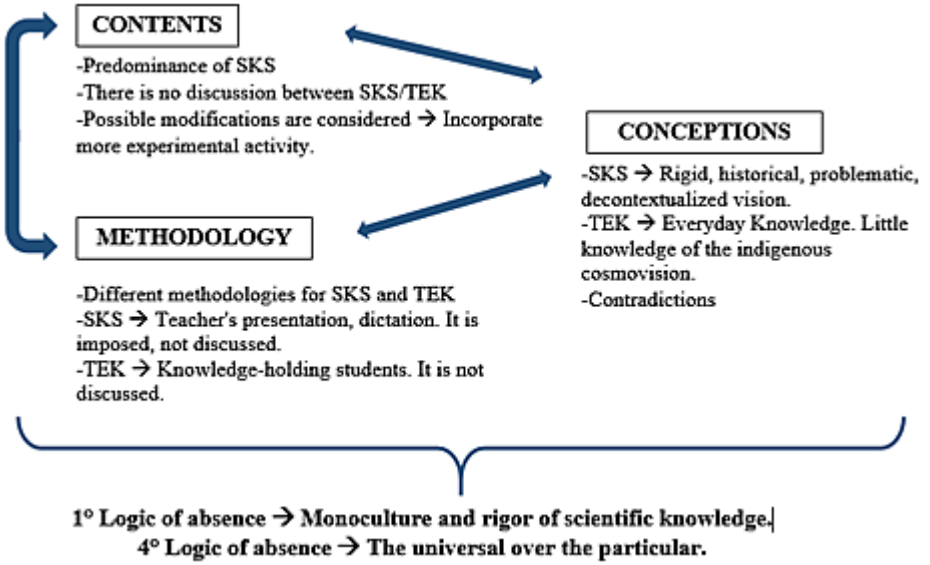
We highlight some key moments that highlight relationships between teacher's and students' conceptions of NoSKS and NoTEK:

1. On several occasions, the students show expressions of disagreement or disapproval of some of the teacher's affirmations; the attitude on the origin of man described above is emblematic in this regard. As stated by Valladares-Riberoll (2011), if the scientific vision prevails in the classroom, the wisdom of the ancestors of the indigenous communities to which the students belong is jeopardised.
2. The students seem to accept the teacher's classification of TEK as every day and vulgar knowledge, and do not defend TEK in the face of this implicit devaluation, either because they are not aware of it, or because they have not been given the space to do so. This dynamic does not allow the TEK to be considered as a body of knowledge in its own right.
3. Despite the teacher's insistence, the students do not refer to the scientific method or to scientific disciplines in the drawing activity and in the mentioning of characteristics about these representative figures.
4. In the students' drawings of the scientist, the association between science and medicine stands out for its novelty with respect to the teacher's discourse. This is a transposition of competences between the main task of the indigenous sage, which is to heal in the broad sense of the word, and what the scientist does. Science is supposed to serve to improve human life, but unfortunately this is not always the case today.
5. In the drawings about the indigenous sage, the students recognise that nature is a key element, but there is not much clarity and consensus about the image of the sage, his skills, and competences within the indigenous society. This shows, once again, the insufficient treatment of TEK in the classroom and the non-existent problematisation and confrontation between TEK and SSK.

Figure 6 summarises the discussion.

Figure 6

Synthesis of results and discussion.



FINAL REFLECTIONS

Let us remind that looking at reality under an intercultural approach not only implies the recognition of diversity but also the identification of power relations and/or domination of some over others. This means that some cultures or socio-cultural groups impose themselves as universal over others (at the macro level) or some people over others (at the micro level). These relations of domination are expressed in the form of discrimination, racism, exclusion, in short, relations that have led to the silencing of various socio-cultural groups on a social, political and cultural level, and which are sometimes unnoticed. In the description of these classes, these power relations between knowledge are evident. The subject of "Natural Sciences" is determined by the SKS and the potential of indigenous knowledge as a transversal axis of the whole subject, whose principles could overcome some biased and limited conceptions of science, is neglected. Furthermore, according to Voltolini and Kaiber (2017), community knowledge not only contributes to strengthening indigenous culture and identity but can also help facilitate student learning. Therefore, it is

necessary to establish guidelines that allow for epistemic openness in this disciplinary space.

The teacher's curricular decisions are positioned under an assimilationist and moral-humanist perspective (Molina and Mojica, 2013): scientific knowledge is the protagonist, the diversity of knowledge is recognised but there are difficulties in creating bridges. It is logical that this happens considering the conditions in which the teacher start his work: first time in the modality, he does not have specific guidelines to develop this curricular space, the materials he uses are not specific, among other aspects. Hence, tensions are generated between the teacher's and students' conceptions of SKS and TEK, which are mainly due to the rigidity with which science (SKS) is presented, the little space and credibility given to TEK and the lack of problematisation and dialogical confrontation between TEK and SKS, results that coincide with the obstacles pointed out by Dumrauf and Menegaz (2013). Many questions remain unresolved due to the absence of dialogue between knowledge based on epistemic equity. For both NoTEK and NoSKS. the difficulty lies in not problematising the content being addressed, not generating questions and debates between knowledge, in agreement with Aikenhead and Huntley (1999). For this reason, it would be important to construct alternatives in this specific space that would allow the teacher to have other strategies and/or resources to develop the subject. These actions would facilitate the construction of new knowledge and learning together.

In turn, these issues respond to the distinctly Western training of science teachers. A training that alludes to and insists that the only knowledge to be taught is scientific knowledge, which is reflected in their conceptions (Petty and Narayan, 2012). On the contrary, we argue that it is necessary to propose an epistemological openness in education in general as well as in science teachers training. Are there possible alternative paths and solutions? The answer lies in terms of emergencies (Santos, 2013): mediating encounters that mobilise and provoke reflection on cognitive injustice, the prejudice of the monoculture of knowledge, the hegemony of Western thought, power relations and their consequences, involving and making communities responsible for this transformation (López, 2014) as is their right (OEA, 2016). In fact, making explicit absences and emergencies can be an important driver of questioning and continuous meta-reflection for EIB and in the educational context in general. We insist that the aim is not to discredit SKS but to legitimise the existence and validity of other knowledge and that this dialogue would also enrich the conception of science.

In conclusion, interculturality must be used as a problematising tool in order to incorporate epistemological, historical, philosophical, sociological and other issues

into the subject. This will make it possible to resize the power of truth of science and to value TEK as a system of knowledge, whose fundamental value is the respect and preservation of nature.

The authors continue in this commitment by studying and experimenting with strategies for teaching and learning about knowledge of the natural environment based on joint work and dialogue of knowledge between different actors: teachers, students/future teachers, indigenous scholars and the academy.

STATEMENT OF AUTHORS' CONTRIBUTIONS

TEV has conceived the research, contacted the Institute, collected and analysed the data and created the final report. VA took part in the ideation of the research, provided the initial methodological framework, supervised and validated the research process and edited the document. Both authors have actively participated in the discussion of the results and in the conclusions, working together in this final version of the manuscript.

DATA AVAILABILITY STATEMENT

Data supporting the results of this study will be provided by author Tatiana Edith Vergara, upon reasonable request.

REFERENCES

Acevedo-Díaz, J.A., García-Carmona, A. (2016). Algo antiguo, algo nuevo, algo prestado. Tendencias sobre la naturaleza de la ciencia en la educación científica. *Revista Eureka sobre Enseñanza y Divulgación de las Ciencias, 13*(1), 3-19. https://doi.org/0498/18010

Albanese, V., & Perales, F. J. (2020). Mathematics Conceptions by Teachers from an Ethnomathematical Perspective. *Bolema: Boletim de Educação Matemática, 34*(66), 1-21. http://dx.doi.org/10.1590/1980-4415v34n66a01

Aikenhead, G. & Elliott, D. (2010). An emerging decolonizing science education in Canada. *Canadian Journal of Science, Mathematics and Technology Education, 10*(4), 321–338. https://doi.org/10.1080/14926156.2010.524967

Aikenhead, G. & Huntley, B. (1999). Teachers' views on Aboriginal students learning western and Aboriginal science. *Canadian Journal of Native Education, 23*(2), 159-175.

Boisselle, L.N. (2016). Decolonizing Science and Science Education in a Postcolonial Space. *SAGE Open, 6*, 1-11. https://doi.org/10.1177/2158244016635257

Caetano, H. & Neto, A.J. (2005). Natureza e ensino da ciência: investigando as concepçoes de ciencia dos professores. *Enseñanza de las Ciencias*, Extra, 1-5.

Cañal, P. (2000). Las actividades de enseñanza. Un esquema de clasificación. *Investigación en la Escuela, 40*, 5-21.

Dumrauf, A. & Menegaz, A. (2013). La construcción de un currículo intercultural a partir del diálogo de saberes: Descripción y análisis de una experiencia de formación docente continua. *Revista Electrónica de Enseñanza de las Ciencias, 12* (1), 85-109.

Espínola, V. (1992). *Principios y prácticas de la adecuación cur*ricular. Centro de Investigación y Desarrollo de la Educación de Chile.

Estermann, J. (2014). Colonialidad, descolonización e interculturalidad. Apuntes desde la Filosofía Intercultural. *Polis, Revista Latinoamericana, 13*(38), 347-368.

Fernández, I., Gil, D., Carrascosa, J., Cachapúz, A., & Praia, J. (2002). Visiones deformadas de la ciencia transmitidas por la enseñanza. *Enseñanza de las Ciencias, 20*(3), 477-488. https://doi.org/10.5565/rev/ensciencias.3962

Higgins, M. (2016). Decolonizing School Science: Pedagogically Enacting Agential Literacy and Ecologies of Relationships. In C. A. Taylor, & C. Hughes (Eds.), *Posthuman Research Practices in Education* (pp. 267–289). Palgrave MacMillan. https://doi.org/10.1057/9781137453082

INDEC-Instituto Nacional De Estadística y Censos (2010). *Censo Nacional de Población, Hogares y Viviendas 2010. Censo del Bicentenario. Pueblos Originarios*. Ministerio de Economía y Finanza Pública.

López, L. E. (2014). Indigenous Intercultural Bilingual Education in Latin America: Widening gaps between policy and practice. In R. Cortina (Ed.), *The Education of Indigenous Citizens in Latin America* (pp. 29-49). Multilingual Matters.

Maimone, M. D. C., Edelstein, P., Cabrera, J., & López, P. (2021). *Pueblos indígenas, sectores populares y educación. Aportes para la enseñanza intercultural en las escuelas.* Departamento de Educación, Universidad Nacional de Luján.

Martínez-Sarasola, C. (2010). *De manera sagrada y en celebración. Identidad, cosmovisión y espiritualidad en los pueblos indígenas*. Biblos.

Mato, D. (2009). No hay saber "universal", la colaboración intercultural es imprescindible. *Alteridades, 18*(35), 101-116.

McMillan, J. H. & Schumacher, S. (2005). *Investigación Educativa*. Pearson.

Meinardi, E. (2017). Interculturalidad y enseñanza de las ciencias: una perspectiva que nos lleva a revisar críticamente nuestras concepciones tradicionales sobre las finalidades de la educación. *Revista de educación en biología*, *20*(2), 113-119.

Mignolo, W. (2010). *Desobediencia epistémica*. *Retórica de la modernidad, lógica de la colonialidad y gramática de la Descolonialidad*. del Signo.

Moral, C. (2006). Criterios de validez en la investigación cualitativa actual. *Revista de Investigación Educativa, 24*(1), 147-164. https://doi.org/10.4321/S1132-12962009000200012

Molina, A. y Mojica, L. (2013). Enseñanza como puente entre conocimientos científicos escolares y conocimientos ecológicos tradicionales. *Magis, Revista Internacional de Investigación en Educación, 6*(12), 37-53.

OEA - Organización de Estados Americanos (2016). *Declaración Americana sobre Derechos de los Pueblos Indígenas durante la cuadragésima Asamblea General de la Organización de Estados Americanos*. OEA

Oficina Regional de Educación para América Latina y el Caribe/Organización de las Naciones Unidas para la Educación, la Ciencia y la Cultura (OREALC/UNESCO Santiago) (2017). *Conocimiento Indígena y Políticas Educativas en América Latina*. OREALC/UNESCO Santiago.

Petty, L. L. & Narayan, R. (2012). Investigating secondary science teachers' beliefs about multiculturalism and its implementation in the classroom. *Multicultural Perspectives, 14*(4), 212-219. https://doi.org/10.1080/15210960.2012.725327

Pujalte, A., Bonan, L., Porro, S. & Adúriz-Bravo, A. (2014). Inadequate images of science and scientists as a focus of the nature of science: state of the art and outstanding issues. *Ciência & Educação, 20*(3), 535-548.

Sánchez, O. (2009). *Rasgos culturales Tobas*. Librería de la Paz.

Santos, B. de S. (2010). *Descolonizar el saber, reinventar el poder*. Trilce.

Santos, B. de S. (2013). *Una epistemología del sur: la reinvención del conocimiento y la emancipación social*. Siglo veintiuno.

Schettini, P. & Cortazzo, I. (2015). *Análisis de datos cualitativos en la investigación social*. Editorial Universidad Nacional de La Plata.

Stake, R. (1998). *Investigación con estudio de casos*. Morata.

Valladares-Riveroll, L. (2011). Un modelo dialógico intercultural de educación científica. *Cuadernos Interculturales, 9*(16), 119-134.

Voltolini, L., & Kaiber, C. T. (2017). Educação Escolar Indígena e Educação Matemática: um estudo na Comunidade Indígena Serra da Moça. *Acta Scientiae*, *19*(4), 619-639.