

# Interculturality and Meaningful Learning: Indigenous Schooling Education in Natural Sciences Teaching

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**Keywords—** Decolonization, Indigenous Teaching, Interculturality, Meaningful Learning, Natural Sciences, Teaching Materials.

**Abstract—** The objective of this paper is to analyse the possibility of an intercultural dialogue in Natural Sciences teaching; the study is centered in David Ausubel's Meaningful Learning Theory and geared to indigenous students. It highlights the concepts that guide the meaningful learning concomitantly to the conceptual pillars of interculturality, treasuring the indigenous knowledge during the entire journey, and also, the premise that Maths and Sciences teaching must take place out of necessity and/or concrete situations. This study points the great didactic conceptual advantage of the utilization of the ethnophysics knowledge to represent and model the main concepts of Natural Sciences, it yet discourses about local conceptions and the pedagogical practices of teachers; the elaboration of an alternative school material contextualized with the indigenous reality, and the comprehension of the process that was fundamental to a meaningful answer of the indigenous students concerning Mathematics and Natural Sciences teaching. Reflections were proposed to enable the Teaching of Mathematics and Natural Sciences from an intercultural perspective, as it brings the possibility of analysis, aiming at the decolonization of knowledge and, therefore, the imagery that supports it.

## I. INTRODUCTION

In our study, we will seek theoretical support in David Ausubel's Theory of Learning, the relationship of interculturality in the student's cognitive development in the search for a meaningful student learning in Natural Sciences. The importance of this study will enable indigenous teachers to seek transversal pedagogical strategies that value sustainability, in order to maintain their leadership, their traditional customs and values added to the contents covered in the classroom and beyond.

It should be noted that indigenous teachers demand the development of new pedagogical and curricular proposals applicable to their schools to replace the general model of the current educational system. The reason, as recorded by the Ministry of Education and Culture (2002, p.11), is that

“such models never corresponded to their political interests and the pedagogies of their cultures”. Furthermore, it is a viable proposal in the current context of the classroom, as teachers and students become constructors of an educational practice for an inclusive and intercultural school.

We can also consider, based on the few found researches, that these seek to motivate learning in Natural Sciences when they try to somehow relate traditional knowledge in Natural Sciences to school knowledge in the classroom and beyond.

In order to establish a relationship between the proposed Teaching of Natural Sciences with the intercultural context in indigenous communities, that is, culture, territory and sustainability, it is primarily necessary to understand the

concept of each one of them, given to their relevance for the development of the theme. The clarification of these concepts aims at the interrelationship between them, pointing to the issue of sustainability of indigenous school education.

As a consequence, we gathered up our experience. Therefore, the text is organized in three parts: at first, we will deal with David Ausubel's Theory of Meaningful Learning, because in our conception, his theory reaches a fundamental point in the teaching/learning process, where the individual is the subject of their learning, which depends on their prior knowledge and interactivity with the environment, which provokes significant new meaningful knowledge. Then, we will approach the concept of Interculturality in the Teaching of Natural Sciences, a concept defended here that proposes the mutual recognition of all cultures, without hierarchization and superiority of knowledge. In the third part, we develop the implications of the concepts of Meaningful Learning Theory and Interculturality in the cognitive development of the indigenous student, enabling a meaningful intercultural learning.

## II. AUSUBELIAN LEARNING MODEL

In the mid-1960s, David Ausubel proposed the Meaningful Learning Theory, through which he sought to explain the internal mechanisms that occur in the human mind in relation to learning and the structuring of knowledge, through an organization of the individual's cognitive structure. Ausubel focused on an issue that no researcher had ever been concerned about: the learning that took place in the classroom, valuing discovery learning, which encouraged expository classes, a major focus of his research (MOREIRA, 2001).

In our conception, Ausubel reaches a fundamental point in the teaching/learning process, where the individual is the subject of their learning, which depends on their previous knowledge and on the interactivity with the environment, which provokes significant new knowledge. The same proposes that, in order for the apprentice to have meaningful learning, there must be three necessary conditions: the offer of new knowledge structured in a logical manner, the presence of previous knowledge in the individual's cognitive structure so that the bridge can be built. with the new knowledge, and, finally, the intention/purpose of apprehending/assimilating your knowledge with the one you want to achieve.

The individual's cognitive structure, for the author, is the organized content of ideas that, in terms of learning particular themes and subjects, refers to the organization of

content in that area that the individual wants to learn. In other words, the emphasis is placed on the acquisition, storage and coordination of ideas in the individual's brain. Based on this, the cognitive structure would be the set of cultural references that the subject has, since culture guides the individual's perception and cognition codes, favoring the acquisition, organization and anchoring of new knowledge.

In this perception, the cognitive structure of the individual for Ausubel (2003) is structured and organized, and new ideas are articulated according to the relationships that are established between them. Furthermore, it is in the individual's cognitive structure that new ideas and concepts gradually become fixed and organized, that is, learning.

According to his theory, the continuous incorporation of new ideas in the individual's cognitive structure provides learning due to the changes that occur in it. Learning can be mechanical or meaningful, where the main factor will be the relationship that the individual will make with the proposed new idea and previous knowledge already existing in their cognitive structure. In other words, if the new idea is significant for the individual, significant learning will occur, otherwise, it will be mechanical (MOREIRA, 2001).

Thus, when introducing to an indigenous student the concept of speed, for example, it will only be meaningful to them if somehow there is a clear relationship between the "Maraca Race", very common in indigenous communities' games, as the runner who arrives first covered the distance in less time, that is, had a greater speed. Thus, the new idea is related in a non-arbitrary way to the ideas that already exist in the individual's cognitive structure. Precisely because it is not arbitrary and substantive, there is a clear and coherent relationship between the new idea and previous knowledge, resulting in meaningful learning.

In addition to not being arbitrary, for learning to occur, and for it to be meaningful, it also must be substantive. Being substantive, the student will know how to explain the apprehended content in their own words and different ways that express the same meaning of the content. (ARAGÃO, 1976).

For instance, when the Basic Education student learns significantly that the concept of displacement and distance covered are different, that is, that displacement is a vector physical quantity, as it is characterized by intensity, direction and meaning, which mathematically would be the difference of final and initial position of the object. The distance covered, on the other hand, is a scalar physical quantity, which is characterized by an intensity, which

mathematically would be the sum of all the distances covered. In view of this, learning was also significant due to its substantivity, considering that the student grasped the meaning and concepts of what was taught, in such a way that he is able to express himself variably when explaining what was learned.

For Ausubel (2003), the main objective of academic teaching revolves around ideas being learned in a meaningful way; which allows the student to use the new concept learned in an original way, that is, unique, regardless of the environment in which this new content was first learned.

However, one cannot talk about meaningful learning without commenting on mechanical learning – opposite extremes, and unfortunately, the latter is very present in indigenous schools. In this case, the new ideas are not logically and clearly related to prior knowledge in the student's cognitive structure, they are simply memorized and reproduced, circumstances in which they are stored arbitrarily, which does not guarantee flexibility in their use, nor longevity.

As a consequence, substantial learning does not occur, therefore, the individual is not able to express the new content in a language different from the one in which this material was first presented.

In fact, the student does not learn the meaning of the new material, but only memorizes the sequence of words that defines it, decoding it. Therefore, he will be unable to use this knowledge in a context other than the one in which it was first presented. In the example given above – displacement and traveled distance – the individual will not be able to make the relationship between them, or even with the fact that displacement is a vector quantity and traveled distance and a scalar quantity.

#### *A. Substantial Factors to Pedagogical Facilitation*

The substantial factors to pedagogical facilitation, as the name implies, promote the action of learning and are related to the selection of the most relevant themes worked on with students. Thus, it is important to select the basic ideas so as not to overload the student with unnecessary information, making it difficult to acquire an adequate cognitive structure (MOREIRA, et al., 2001).

Ausubel (2003) believes that concepts should be presented to students preferably in a broader format, in other words, from the most general to the most specific ideas, as learning by subordination is easier for the individual than by superordination. Therefore, when concepts are worked on, they can be linked in a subordinate way – when learning takes place through subordination, the anchor

concepts necessary to provide meaningful learning are called “subsumers”.

In this sense, when the teacher selects more general ideas/concepts about a particular subject, these will serve as an anchor for future learning. Otherwise, if the choice is for more unique ideas/concepts, it will probably not be significant for the student, as they would be lacking prior knowledge in the student's cognitive structure, as they are associated with more inclusive concepts.

For Ausubel (2003), the programmatic principles for sequencing teaching content are progressive differentiation and integrative reconciliation. Progressive differentiation is characterized by learning by subordination, in which the most global and inclusive ideas must be presented to the individual in advance of the most specific ones, fostering the necessary conditions for anchoring new ideas and their subsequent differentiation. Integrative reconciliation, on the other hand, portrays the relationship between ideas, pointing out similarities and differences, in an attempt to circumvent imaginary or apparent divergences in the idea. That is, as concepts become singular and, simultaneously, establishing relationships that generate meaning, meaningful learning occurs. As defined by Faria (1989), integrative reconciliation basically consists of the explicit delineation of the relationships between ideas, of pointing out relevant similarities and differences, and of reconciling real and apparent inconsistencies.

However, we must be careful, when we present new ideas to those that already exist in the student's cognitive structure: clarify any differences between the already established ideas and those that are being learned, so that the student does not take the junction one with the other or the confuse the concept of both. Highlight any contradictions and similarities between the concepts that are being learned and those that are already known; analyze the new idea within the limited set of concepts related to a discipline, so that any contradiction disappears.

#### *B. Previous Organizers*

After the selection, sequencing and preparation of the most relevant contents in order to ensure clarity and stability of the ideas in the individual's cognitive structure, it is proposed the arrangement of previous organizers. According to Ausubel (2003), previous organizers are introductory materials designed to facilitate the learning of specific topics or sets of ideas that are consistently related to each other.

The previous organizers are intended to reveal in the student's cognitive structure mainstay ideas, in order to stimulate meaningful learning. Consequently, the objective of the previous organizers is to strengthen the formation of

non-arbitrary and substantive relationships with new concepts and ideas that will anchor in the student's cognitive structure, through the explanation of these ideas.

Hence, Moreira (2004) states that the advantage of the previous organizer is to allow the student to take advantage of the characteristics of a subsumer, that is: to identify the relevant content in the cognitive structure and explain the relevance of this content for learning the new material; give an overview of the material at a higher level of abstraction, stressing important relationships, and; provide inclusive organizational elements that take into account more efficiently and enhance the specific content of the new material.

### III. INTERCULTURALITY IN NATURE SCIENCE TEACHING

Firstly, we need to make it clear that the concept of interculturality defended in this study proposes the mutual recognition of all cultures, without hierarchization and superiority of knowledge. From this perspective, we were able to observe and understand the worldview of indigenous peoples, particularly their conceptions regarding the phenomena of the Natural Sciences.

Acknowledging interculturality as a pedagogical and methodological perspective allows us to recognize and value other cultural systems, outweighing hierarchy, in a context of complementarity which enables the construction of a dialogue. This, on the other hand, allows the sharing of knowledge, beyond all the false opposition between the modern and the traditional, written and oral culture, rationality and the affective dimension. These false oppositions pervade human relationships and learning (NARBY, 2000, 2005).

The concept of culture we adopt is essentially semiotic, as we believe culture as the accumulated totality of cultural patterns, that is to say, of "organized systems of significant symbols" (GEERTZ, 1989) on the basis of which individuals organize and guide the purposes of their actions.

It is a fact that we still find in indigenous school education the ideological vision of the colonizers in the Teaching of Natural Sciences, we believe that is heavily due to the textbooks that are sent to indigenous schools, as they pass on contents with rather a western worldview in order to reduce the them to mere mnemonic information, not recognizing local knowledge and their culture as important assets in the process of meaningful learning, hence harming the teach-learning process, since recognizing the other's culture as significant is what allows groups to talk to each other.

Thinking about Natural Sciences teaching from an intercultural perspective, brings the possibility of analysis that allows the decolonization of knowledge and, consequently, the imaginary that sustains it. Taking interculturality as a perspective enables the recognition and appreciation of other cultural systems, in addition to any hierarchy to foster dialogue.

This approach brings out the proposition of interculturality with the decolonization of power and knowledge. It is, therefore, the cultural and historical foundation in the production of an alternative teaching material which incorporates their cultural diversity and contextualized with their indigenous reality, thus respecting the richness of diversity as significant in the student's learning process.

Reflecting on the response of local knowledge relationship, which is identified by some as inferior to global knowledge, leads us to study the history of power relations between dominant cultures and dominated cultures.

The axis of this reflection allows me to question the historical separation of nature and culture in the teaching of Science, put into practice by the Eurocentric vision situated in the rationality of positivism, on which the normal science defended by the ruling class was built. I understand that normal science is the state of a science in which its research and results are predictable, that is, it is not concerned with creating novelties, but with specializing in what is already established by the current paradigm. The intention of the experiences is not to institute novelties, in fact, "The result is already known in advance, the fascination is in how to reach it" (KHUN, 2009, p. 60).

There are several challenges to teach Science for an indigenous community; which are, to understand their culture and their particularities, to talk to the community and most importantly, to listen to them - not merely talk about them or for them. (LINS, 2019) corroborates with this assumption when he defends that an individual should talk to one another, without letting their own conceptions about science prejudice the so-called common sense knowledge by normal science, this is perhaps the greatest paradigm.

Furthermore, current Education theorists have been endeavoring to involve interculturality in the Natural Sciences teach-learning process. In Brazil, the situation of coexistence of different cultures has always existed and has always been part of our reality, however, in an oppressive way, the dominant ideology has always sought to devalue the cultures dominated throughout the colonial and post-colonial period.



It is important to mention that intercultural teaching provides interaction with other people and provides an understanding of the meanings attributed to their actions. These actions may cause discomfort with other people's behavior due to the fact that logic determines the cultural context, differently from the typical logic of our cultural standards. In order to understand another person's behavior, you need to comprehend the logic of the organization, and also, meaningful symbols developed by their group.

Whilst, comprehending the logic of different cultural patterns allows us to understand, by contrast the peculiarities of the logic of our own cultural patterns and the relativity of the meanings we attribute to our acts. In this way, by reflecting on our actions from the perspective of other cultural patterns, we can discover other meanings that our own actions can take and, with that, discover different ways to guide them.

When referring to Indigenous Education, D'Ambrósio (2001, p.76) points out that education must use contextualized resources and instruments, as "contextualization is essential for any education program for native and marginal populations". Furthermore, he shows that "it is possible to avoid cultural conflicts that result from the introduction of white mathematics in indigenous education" (Loc. Cit.). By analogy, I believe that the teaching of Science can be approached considering its cultural context, so that the problems found in Science textbooks bring an adequate treatment of formulating and solving problems of physical phenomena found in the working school community, that is, referring to the climate, agriculture, fishing, what applies to the daily life of the community.

[...] everyday life is impregnated with the knowledge and practices of culture. At all times, individuals are comparing, classifying, quantifying, measuring, explaining, generalizing, inferring and, in some way, evaluating, using the material and intellectual instruments that are characteristic of their culture (Idem, 2002, p. 22).

The Mathematics defended in this study is based on the needs and/or concrete situations of the community itself. In this case, I sought to encourage the permanence of indigenous culture through the teaching of Mathematics proposed by Ethnomathematics, as follows:

[...] the mathematics practiced by cultural groups, such as urban and rural communities, groups of workers, professional classes, children of a certain age group, indigenous societies, and many other groups that identify themselves by objectives and traditions common to the group. (Idem, 2001, p. 9).

Agreeing with the author, I believe that both Science and Mathematics must be linked to real and natural phenomena; and a great example is in indigenous school education. The common sense of the indigenous people, for example, elders, fathers, mothers and chiefs are inexhaustible sources of scientific knowledge.

Consequently, trying to understand and often accept new cultures is not an easy relationship in our daily lives. History reveals to us that many of such relationships between different peoples and social groups have resulted in holy wars, genocides, processes of colonization and domination. According to Geertz (1984, p.54), "understanding the culture of a people exposes its normality without reducing its particularity", thus bringing, according to history, deeply conflicting and dramatic relationships.

According to Messeder (2018, p.10), "culture is a symbolic plot that organizes and guides the collective senses of being in the world, a cognitive and perceptual map translated into codes of behavior, of human beings' relationships with nature and among themselves". Culture as a language that can only be understood in its own context and logic of conception, enunciation and practice.

Therefore, understanding such processes of intercultural relations becomes the condition to understand not only the logics that lead to mutual destruction or subjection, but, above all, to discover the creative and dialogical possibilities of relations between different groups and cultural contexts, making, thus, the differentiated and adequate intercultural teaching material for certain realities.

In the conception of D'Ambrósio (2002), intercultural relations must be understood in a planetary dimension in which the mass media would facilitate the transport of this cultural plurality. Thereby,

[...] the relationships between individuals from the same culture (intracultural) and, above all, the relationships between individuals from different cultures (intercultural) represent the creative potential of the species. Just as biodiversity represents the path to the emergence of new species, cultural diversity represents humanity's creative potential (p. 28).

For Fleuri (2009), intercultural relationships are not relationships whose meanings are configured from singular, individual perspectives, nor are they consolidated in a short time. The formation of cultural patterns and the educational processes inherent to it are configured in the paradoxical intertwining of many perspectives that, for this very reason, constitute themselves dynamically and conflictually. And although each act has effects that

contribute to the configuration and transformation of cultural patterns, these only constitute long-term historical processes.

Therefore, the intercultural perspective implies a complex understanding of education that seeks - beyond pedagogical strategies and even immediate interpersonal relationships - to understand and promote, slowly and progressively, the formation of relational and collective contexts for the elaboration of meanings that guide life of people from collaborative principles.

Studying a people, a community, or just a group of rural workers, is entering the intended daily life, it is talking, listening, understanding the process, understanding the origins, never losing individuality, but taking into account the generalization of activities, analyzing each word, realizing in small details the scientific background that exists, remembering that, "even so, these descriptions and interpretations will always be from the point of view of a scientific interpretation" (SILVA, 2003).

In this way, to achieve the proposed objectives, I believe that the ethnographic methodology best suits my purpose, since the study of intercultural relations can only develop from interpersonal links in their historical facticity. For a survey with this character,

[...] it is not the event which interests the ethnographer, the raw social discourse in which he did not participate in the construction; rather, it is the meaning of the speaking event - speech acts, of some small parts of the informant's discourse - that can lead to an understanding of reality (Ibidem, p. 4)

In this sense, the relationship between people is a relationship between projects, proposals, and meanings. And the relationship between cultures, which occurs in the encounter between people from different cultures, calls into question all the symbolic apparatus from which each subject is guided. That is what, in my view, the intercultural relationship consists of. Subjects, people from different cultures who attribute different meanings to their actions, when interacting, they question not only the meaning of their action or their speech, but they call into question their entire cultural framework that allows them to give meaning to each of their actions, choices, words and feelings (FLEURY, 1996).

#### IV. IMPLICATIONS OF AUSUBEL THEORY AND INTERCULTURALITY

The compatibility of David Ausubel's learning theory with interculturality brings us extremely positive pedagogical and methodological implications, causing significant knowledge to indigenous students, as the teacher manages

to get closer to the student through interactivity with their background knowledge and the environment in which he is inserted, that is, his culture, his community also making the relationship with the concepts addressed in the classroom and beyond.

Ausubel, when proposing in his theory the necessary conditions for a meaningful learning, we observe that it provides an interdependence of the cultural concepts in which the student is inserted. For, in new concepts presentation, knowledge must be presented in a logical and structured way, associated with the cultural conceptions to which the individual is inserted. Likewise, prior knowledge so that the individual can "bridge" with new knowledge and, finally, the intention to apprehend their intercultural knowledge with the one they intend to achieve.

Another important factor is that in the activities proposed by teachers of Nature Sciences in the classroom and beyond, is the way in which this new structured concept must be presented to the student, that is, from a more general and broad to a more specific way. In other words, an approach associated with their cultural and social context will allow a better assimilation of the new concept to their previous knowledge, providing opportunities for meaningful learning by the student.

Thus, the challenge of the indigenous teacher to teach Nature Sciences in an intercultural way is to understand that their culture and particularities linked to the common sense of the respective ethnicity can dialogue with normal science. Therefore, their cultural knowledge is essential and must be valued at all stages of teaching, since the Natural Sciences is also founded as part of social and cultural traditions. And in our view, the ratification of the cultural context will favor a presentation of the content in a more global and dialogic way towards a more scientific one, favoring the anchoring of the new knowledge provided.

#### V. CONCLUSION

This work aimed to verify the possibility of an intercultural dialogue in the teaching of Natural Sciences guided by David Ausubel's theory of meaningful learning, aimed at indigenous students. It is worth confirming that the trajectory of our work was guided by Ausubelian cognitivism, parallel to the concept of interculturality. In this sense, the guiding concepts of meaningful learning were worked on along with the conceptual pillars of interculturality, valuing indigenous knowledge throughout the course.

The study convinced us of the great didactic-conceptual advantage of using ethno-physical knowledge to represent and model the main concepts of Physics, that is, of the Natural Sciences. This is due in large part to the capacity of the existing dialogue between the indigenous culture and the natural phenomena studied in Natural Sciences. We believe that the local conceptions, the teachers' pedagogical practices and the understanding of the process were fundamental for the significant response from the indigenous students.

Thus, the relationship between the teaching of Natural Sciences and, consequently, the intercultural and ethnographic context, thus enabling community dialogue, which intrinsically brings their prior knowledge, that is, more general, serving as a bridge to more specific knowledge, that is, scientific. Recognizing, therefore, the importance of culture in the construction and enhancement of local knowledge or an ethnic group.

In this way, we believe in the possibility of intercultural dialogue in the construction of the teaching of Nature Sciences that is responded positively. It is noteworthy that the participation of indigenous teachers and the community proved to be unique in the search for similarities and differences between the ideas that are represented in indigenous culture and scientific knowledge itself.

Therefore, the relationship between Natural Sciences teaching must have in its epistemological basis, an intercultural and ethnographic context, hence enabling community dialogue, which intrinsically brings their prior knowledge, serving as a bridge to more specific- or in other terms, more scientific- knowledge. Recognizing, therefore, the importance of culture in the construction and enhancement of local knowledge or an ethnic group.

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