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The *Soil* concept for Indigenous Teachers from Acre State, Brazilian Amazon Region

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***Abstract*—** *In Brazil, indigenous education has not historically prioritised the preservation of indigenous culture. From the 1990s onwards, however, the presence of indigenous teachers in the Amazon region led to a definition of indigenous education policies that value the culture of the people. The formation of indigenous teachers in Brazilian universities involves non-indigenous professionals, and to this end, appropriate methodologies (ethno-methodologies) should be developed. Action-research as a methodological approach allows flexibilization of educational content and was applied to indigenous teacher training courses at Indigenous Teachers Training Course-CFDI, in the Federal University of Acre-UFAC, in the state of Acre, Brazil. This methodological approach addressed the concept of soil, building on the daily village life of each student. As such, previous knowledge, both individually and collectively held, assisted the acquisition of new knowledge. In classes, the indigenous students indicated that the soil serves two basic functions in their daily lives, depending on its mineralogical characteristics: agriculture (sandy soils) or ceramics and construction (clay soils).The approach in intercultural education situations from action research, allows teachers not expert ethno methodologies develop content from the experience of the students.*

***Keywords*—Geoscience Education, Indigenous Education, Action-Research, Intercultural Education.**

I. INTRODUCTION

Differentiated education, in addition to the indigenous education, has recently been developed in the Brazilian educational scenario. For more than 30 years, the indigenous education was limited to and protected by the National Indian Foundation (Fundação Nacional do Índio, FUNAI), which is a specific federal organ. During this period, the training of indigenous teachers was focused on bilingual literacy and mathematics. However, in 1991, the Ministry of Education and Culture (MEC) became responsible for coordinating indigenous education initiatives (Monte 2000), after the UN Declaration was incorporated into the 1988 Brazilian Constitution. The Brazilian Constitution guaranteed the rights of the population to remain indigenous and the maintenance of their cultural identity, thus enabling the indigenous school to become a recovery tool of language, knowledge and indigenous traditions.

These rights granted to indigenous peoples in the 1988 Constitution are the result of international policy and actions of the indigenous themselves, which, along with the movements of supporting indigenous populations, have articulated the need to bar discriminatory actions against indigenous interests, participating in the discussions so that their rights would be recognised.

During this period, education was one of the prior action plans applied to the national legislation and to public policies related to indigenous peoples (Ferreira 1992 and 2001; Caplaca 1995; Dias da Silva 2000). In recent years, Brazil has developed several initiatives with the objective of creating and reforming schools within indigenous communities (BRAZIL 1993).

Accordingly, throughout history, schooling has often promoted loss of indigenous cultures. We have observed that a strong ethnocentrism is present in many of these practices:

(i) In general, such initiatives support the understanding (or ideological belief) that school is an instrument of social promotion;
(ii) Usually, such initiatives share the ideological understanding that “the Indians” have to “match up” to other cultures to be respected and for their voices to be heard and school is seen a major vehicle for this “equalisation”;
(iii) “Differentiated education” is generally thought of as a school program in which a place is (also) given to the “ethno-knowledge of the group” and this type of school is consistently described as an “ethno-school”;
(iv) An “ethno-school” is ultimately an “adapted school”, a feature that is always highlighted in the “differentiated” curricula, which, more often than not, is covered with a layer of “culture”;
(v) Most of the time, the emergence of “ethno-schools” is not urged by political indigenous movements that provide independent guidance; in fact, they result from naive perspectives of indigenous leaderships or

from "redeeming" perspectives of the role of school held by external agents(D'Angelis 2000).

Several initiatives were references for the conceptualisation and implementation of indigenous education public policies based on specificity, difference, interculturality and linguistic diversity (Ministério da Educação e Desportos1993, 1997, 1998, 1999).

In all regions of Brazil, indigenous teacher training courses have been structured on an on-going basis and formed bilingual monitors (with alphabetisation in Portuguese and indigenous languages). The new proposals aimed to respect the linguistic aspects of the indigenous societies. These first projects are focused on training young indigenous individuals who were chosen to take leadership roles within the community, and enabling them to manage organised cooperatives in charge of indigenous health and education in addition to struggling for attainment and management of indigenous lands (Monte 2000).

In the Amazon region (Acre, Amazonas and Roraima), such projects have contributed to the development of an indigenous school education policy that impacts on the history of indigenous peoples in Brazil. In this sense, school favours the reconstruction and positive standing of indigenous culture and identities (Silva 1999).

One of the main educational goals is the possibility of using education to preserve the specific socio-cultural context from each ethnic group. This highlights the importance of providing a bilingual indigenous education, preferably provided by indigenous teachers in indigenous schools built in the villages, using curriculum programs defined by the communities themselves.

Therefore, training activities for indigenous teachers should focus on identifying teaching practices that address the culture and knowledge of the students through study topics that form the school subject content.

In addition to dealing with the cultural complexity, professors working in college courses that train indigenous teachers must also be able to accommodate the students' native language. This requires the adjustment of terms used in the classroom because these students, after their graduation, will teach in their villages in both Portuguese and their native language.

According to these teachers' perspective, the school curriculum is a significant communication and intercultural social action. Curricula are processes that build historical meaning, which includes teaching–learning relationships at school (Monte 2000).

The pedagogical perspective formulated or synthesised by Paulo Freire—in which the political commitment to social change, the anti-colonial stance and the resolve against political alienation, are explicit and essential components—is the most appropriate proposal for the development of an indigenous school (D'Angelis 2000). This perspective necessarily highlights the development of autonomy, which is a result of one pedagogical–political principle of the proposal: "to educate is not to transfer knowledge, but rather to create the possibilities for its construction" (Freire 1996).

The education has become increasingly geared towards homogenisation and globalisation. However, the Amazon indigenous teachers advocate a school from a new meaning and value; they are not accepting simply our educational model, but they use the school environment as a resistance strategy (Silva 1999).

Since the Presidential Decree no. 6.861/2009, which created the ethnical educational territories, several changes were proposed for the indigenous schooling policy in Brazil. From October 2013, when the no. 1.062 Ordinance was published by the Education Ministry, the Programa Nacional dos Territórios Etnoeducacionais (Ethnical Educational Territories National Program) was established (Bergamaschi and Souza 2015).

In fact, for Bergamaschi and Souza, both documents interfered in the indigenous school education policy, not only with the territorial organisation, but also with school management and administration, more emphatically setting the Amerindian protagonism in school education processes (Bergamaschi and Souza 2015).

Today, the situation of indigenous education in Brazil is a complex problem. Although "indigenous schools" were officially recognised by the Brazilian Ministry of Education and Culture in 1991, for years they were categorised as "schools of missionary work" or "schools of Indian reserves" administrated by the Brazilian National Indian Foundation (FUNAI), and became part of the official national framework of education (Guilherme and Hüttner 2015).

In 1999, Brazil had 93,037 students enrolled in Indigenous Education with most concentrated in elementary school, where 74,931 indigenous students were enrolled. Within 1,392 indigenous schools, there were 3,998 teachers; of this total, 76.5% were of indigenous origin. The last school census in 2005 identified 2,323 indigenous schools, and established that among the 8,431 teachers working in these indigenous schools, about 90% had a native Indian background (MEC and INEP 2005). The Brazilian MEC estimates that currently there are 2,819 indigenous schools (MEC 2013).

Guilherme and Hüttner (2015) pointed that there has been an increase in the number of indigenous students in Brazil. They suggest that among the most important factors is the indigenous peoples' awareness that education is a fundamental right and of strategic importance for the maintenance of their societies. Furthermore, the efforts of the Department of Continuing,

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Elementary and Diversity Education (Secretaria de Educação Continuada, Alfabetização e Diversidade) within the MEC have helped states and municipalities to expand provision of indigenous schools and funding by SECAD/MEC, which aims to provide training to indigenous teachers. In addition, the national programme for free a school meal, which pays special attention to students with an indigenous background, helps to tackle drop-out issues. Finally, indigenous populations have been estimated to grow at the rate of 4% whilst the national average growth in Brazil is 1.4%.

Despite the governmental support, there is a high drop-out rate of indigenous students; from the enrolment of 89,074 students in the initial years of elementary education, only 12,152 students attend secondary education, and there is no clear research to establish the reasons for such negative rates (Guilherme and Hüttner 2015).

A third of indigenous schools are currently based in locations that are not ideal for the operation of a school, and do not provide pedagogical equipment, such as computer rooms, a science lab, a library in situ, a TV set and satellite dish, and access to the Internet (Guilherme and Hüttner 2015).

According to Curso de Formação Docente Indígena (CFDI) and University of Acre (UFAC) teachers, the logistics and infrastructure represent further problems, because some of the classes are given in the UFAC headquarters in Cruzeiro do Sul village while other classes are taught in the students' villages, which can be accessed only via the Amazonian rivers.

Training of indigenous teachers in Acre

Sixteen peoples represent the indigenous population in Acre, and 14 officially known peoples have contact with white society (*nauá*), namely: Ashaninka, Katukina, Poyanawa, Madija, Manchineri, Jaminawa, Kaxinawá, Nawa, Nukini, Yawanawá, Apolima, Kaxarari, Shanenawa and Arara. However, there are peoples known as "emerging" or "resurrected" that have remained unknown for a very long time, or that were previously considered extinct (Ôchoa et al. 2003). Acre still holds indigenous populations who have no contact with outsiders, and who live in voluntary isolation. There is little or no information about these isolated populations and therefore their customs, culture and language are unknown.

Since the beginning of the 1980s, Acre State has had an important history of indigenous teacher training, which is represented by the actions of the non-governmental organisation known as the Pro-Indigenous Commission (Comissão Pró-Índio-Acre) (CPI / AC).

The Indigenous Education Coordination of the State Education Department – (Coordenação de Educação Indígena da Secretaria Estadual de Educação, SEE) has developed indigenous teacher training in Acre State. It is noteworthy that Acre is the only Brazilian state keeping a training program that benefits all indigenous peoples, respecting these peoples' differences and ethnic groups. The education provided to Acre indigenous populations meets all the current community demands from kindergarten to high school (Martini & Jaminawa 2010). In fact, this training requires a different curriculum. Therefore, these teachers' training must be associated with projects conducted by universities, non-governmental organisations and State departments. These institutions usually define teachers' training based on open or under-construction curricula (Martini and Jaminawa 2010).

The intercultural curriculum adopted for indigenous teachers' training in Acre preceeds the reference for education politics and pedagogical practices indigenous in Brazil. The present study was conducted during the 2009 first school semester at the Indigenous Teachers Training Course (CFDI), in the UFAC in Cruzeiro do Sul County (Fig. 1), Acre, Brazil.

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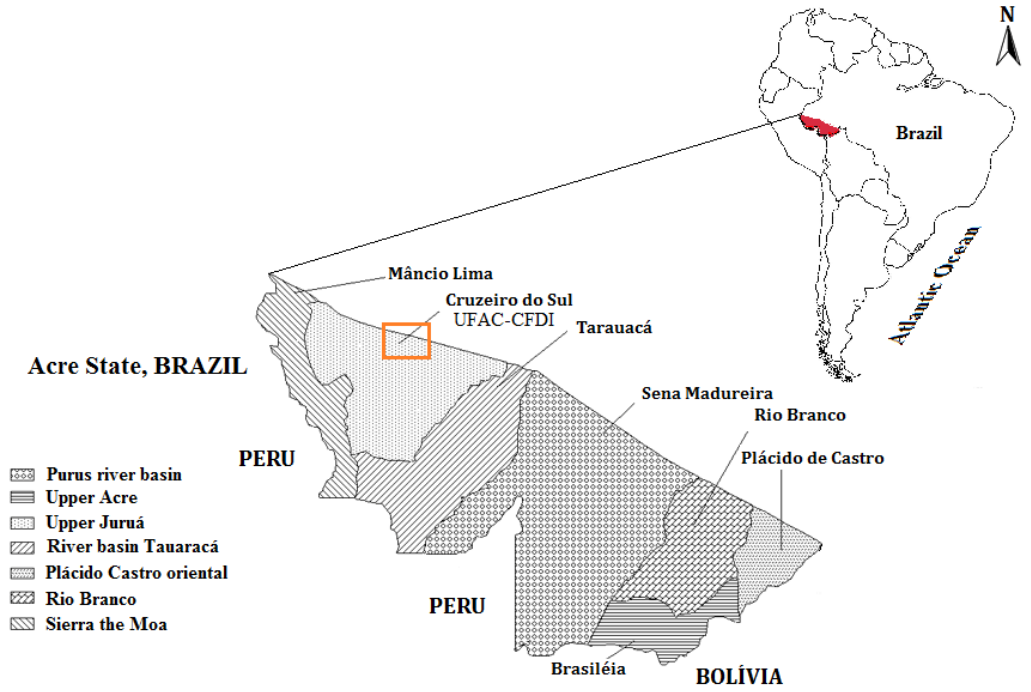

Fig. 1: Location of the CFDI–UFAC, Cruzeiro do Sul, Acre, Brazil

The CFDI is a 4-year long course structured into two modules: the "attendance phase" and "intermediate phase". During the attendance phase, students travel from their villages to Cruzeiro do Sul County; they are hosted by UFAC and attend full-time classes for 2 months.

Theoretical subjects are taught during the attendance phase, which takes from 7 to 15 days, depending on the workload. During the lectures, the teacher works with the students and teaches the theoretical content suggested by the educational programs. Evaluations are performed during the attendance phase to check whether the students passed or failed in the tests.

Each attendance phase is followed by an intermediate phase, during which the CFDI–UFAC teachers travel to the indigenous villages, either alone or in groups, to perform collective teaching focused on student/teacher teaching activities in their villages.

During the fourth, fifth and sixth semesters, students must choose one of the following fields: Social Sciences and Humanities, Natural Sciences, or Arts and Language. After the course is completed, the indigenous students obtain an Intercultural Degree.

Among the main features of the CFDI course is that the indigenous teachers are simultaneously learners and teachers-in-formation; i.e., they are learning the school curriculum, while also preparing themselves to return to their aldeias, or communities, to teach it.

Research goals

According Brostolin (2007) the construction of a genuinely indigenous ethno-education is understood the relationship between teaching and learning. In this context, the research action proposal to allow an analysis of teacher / researcher and student / indigenous, and the meanings of learning for both, in search of an ethno-education.

The application of research action allowed us to analyse the central issue (concepts of soil), from the perspective of indigenous students rather than that of the teacher. This approach was related to the students' daily life, both as members of an ethnic group and as teachers in their villages. More specifically, based on personal narratives and addressing the linguistic and cultural differences of each indigenous ethnic group, we work with students to construct a scientific concept of soil.

II. METHODS

Indigenous students

This study comprised a group of CFDI students from different ethnic groups. The proposed approach from personal narratives, and language and cultural differences of the students included eight students with different ethnicities of Acre (Kaxinawá, Asheñika, Yawanawá, Poyanawa, Shañandawa, Manchineri, Jaminawa and Katukina), and one student from Marubos indigenous village, with ethnicity allocated to Amazonas State.

The age of the indigenous students in the sampling group was heterogeneous because the villages only selected leaders to attend the course (it is noteworthy that in indigenous communities, teachers are considered leaders). These leaders are the elementary school teachers in their

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villages and they teach the early grades to provide bilingual literacy to the children. Elderly individuals, or sons and daughters of former "caciques" (tribal chiefs), or even heads of large families, may be chosen as leaders. Thus, the group consisted of women and men of all ages.

Thus, the teacher/researcher presented to the group scientific contents about the geological processes, specifically, weathering processes. The teachers propose to the students write narratives about the new concepts on the soil topic.

Methodological approaches to overcome cultural language barriers

One of the main educational goals of this study was to investigate the possibility of using education as a way to preserve the specific socio-cultural background from each ethnic group. Among several issues, language is crucial for indigenous schools. During the period of integrationist policies, native indigenous people were forced to learn and speak Portuguese and many children were punished for speaking their own language (Guilherme 2013). This situation contributed to the phenomenon of language-death and cultural demise as members of indigenous communities.

Grupioni (2007) noted that the 2005 census (MEC and INEP 2005) indicated that 78.26% of the indigenous schools employed either the native language or a bilingual approach (either native language or Portuguese; or native languages only for teaching and learning). In accordance with Guilherme and Hüttner (2015), some of these schools (8.57%) did not declare Portuguese to be a taught language, which indicates that they only taught and applied native languages; only 41.54% of these schools used or had access to pedagogical materials in their own language.

The development of pedagogical materials to be used specifically by these indigenous schools is a challenge because there are very few studies on the grammar of some languages and others do not have a standardised alphabetical system. Furthermore, there are additional difficulties associated with producing textbooks using the style of alphabetic characters used within indigenous languages (Bergamaschi and Souza 2015).

This highlights the importance of a bilingual indigenous education, preferably provided by indigenous teachers in indigenous schools built in the villages, using curriculum programs defined by the communities themselves. In the Alto Rio Negro area of the Amazon region, which borders Colombia and Peru, the Ticuna school used a literacy book that was developed by the teachers themselves, the "Ngiã Tanaü tchticü naagü" or Manual de Escrita (Gruber 1992).

Thus, training activities for indigenous teachers should focus on identifying teaching practices able to address the culture and knowledge of students through topics that comprise the school subject's content.

In addition to the difficulties associated with cultural complexity, professors working in college courses developed to train indigenous teachers must also be able to engage with the students' native language. This requires an adjustment of the terms used in the classroom because these students, after their graduation, will teach in both Portuguese and their native language.

Approximately 718 languages are spoken throughout the Amazon region, although some researchers believe that this number could be much larger (Ôchoa et al. 2003). Currently, there are at least 156 indigenous languages being spoken in the Amazon region, although those spoken by resurrected or isolated indigenous peoples are not herein taken under consideration.

Therefore, we considered that the classes that include the indigenous language in the methodological approach should occur both at the micro level (in terms of inter-personal discourse patterns), and at the macro level of societal distribution, i.e., involving the indigenous students in the debates. Hornberger and King (1996) suggested that the revitalisation initiatives for indigenous languages are not so much about bringing a language back, but rather, bringing it forward.

According to linguistic studies, indigenous languages that are most similar to each other are grouped in the same family. The languages grouped into families are, in turn, grouped in linguistic trunks, whenever they show genetic link, and they constitute a common core (Ball 2005). There are three language families in Acre State: Arwak, Arawá and Pano.

Curt Nimuendaju (Neves 2003) performed an ethnological analysis of indigenous land occupation in Acre. His analysis involved determining an analogy between territorial occupation and the spoken languages (Table 1). The indigenous students in Juruá Valley, where FDI is located, prefer to speak their native language, instead of Portuguese. Some ethnic groups, located near the border of Peru, can use Spanish as complementary language to the native language, and these are barriers to be transposed by CDFI professors throughout the student training.

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Table.1: Geographical location of indigenous groups in Acre State river basins: language, familyand cultural relations (adapted from Neves 2003)

LANGUAGE	TRUNK	CULTURAL LOCATION/FEATURES
Aruan	**Aruak**	Found in the mid-course of Purus River, currently in Amazonas State. Groups commonly subdued by other stronger groups took refuge in dry lands and spread to several tributaries in both mid Purus riversides. The Jamamadi and the Kamadeni, as well as many other extinct peoples, were among the different groups within this region. Recent analyses done by linguists attribute approximately 2000 years to this family.
	Aruak	Found in the upper course of Purus River and in the lower Acre River. By going up these rivers, from North to South, it was possible to find the following peoples: Apurinã, Manchineri, Kulina, Canamari, Piros, and Ashaninka, among others. These groups spread from the Pauini and Purus rivers confluence to the Andes eastern slopes approximately 5000 years ago. Pre-History shows that long before resisting the advance of white men on their land, the Arawak or Antis - as the Inca people called them - had already successfully resisted the arrival of Pano language speakers and the expansion of the Andean civilizations.
Takana	**Pano**	Found in the upper course of Acre River, high Iquiri, Abunã and other Madeira River tributaries in the Bolivian territory. Some of them are very pugnacious, such as the feared Pacaguara. Others are more sociable, such as the Kaxarari, since they kept active contact with the Apurinã, despite the language and cultural differences between them. Even though belonging to the Pano language branch, the Takana language origin is more recent, since it emerged between 3000 and 2000 years ago.
Katukina	**Pano**	Found in the intermediate region between the mid-course of Purus and Juruá Rivers, North of Acre. Some of these groups' features indicate relatively recent emergence, approximately 2000 years ago. These little numerous groups were surrounded by the Arawak peoples - to the east - and by the Pano ones - to the west. Thus, they had to exploit the drylands, which were less rich in food supply than the margins of large rivers.
	Pano	Found in much of the mid and upper courses of Juruá River and in most of its tributaries – such as Tarauacá, Muru, Envira, Moa, and the entire region. Kaxinawá, Jaminawá, Amahuaca, Arara, Rununawá, Xixinawá and many other tribal names, are all part of a very old language branch - with approximately 5000 years. This branch originated in another region and more recently invaded Acre territory. The Pano pugnacious nature allowed them conquering their territory through war against different-language- speaker tribes and against groups from the same trunk. It partly explains the high fragmentation showed by many Pano tribes when white people finally got to the region.

Whenever a given theme was discussed, a dialogue is set between the group of indigenous students and the teacher. Each ethnic group identifies the words in their native language that best translate the debate in the classroom. The students formed groups based on ethnicity, with each ethnic group given a name from their native language. Next, they were asked to debate the theme and present a brief report to their other classmates and teacher. Following this exercise, the teachers observed a remarkable fact concerning the dialogues and experience exchanges of the students: they could identify differences and similarities between their various native languages—languages that have been used by their peoples for centuries.

Action-Research as a methodological approach

Ethno-methodological studies in education seek to describe the practices through which the actors of the educational system, including teachers and students, parents and experts, produce such phenomena (Coulon 1995). As such, the valorisation and description of daily life must be present in individual practice and is a key component of the teaching practice.

In the classroom, the teaching strategies are directed to the daily routine of indigenous life, and the theoretical contents should recognise the complexity and diversity involved in indigenous education and valued the preservation of their culture.

The indigenous students' prior knowledge of geoscience content has been previously debated between teachers/researchers and indigenous students. Thus, the knowledge characterised by the empirical knowledge accumulated throughout life and passed from generation

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after generation, and the knowledge produced by science and scientific research were jointly debated and influenced by each other. Indeed, they constituted one single process: the development of concepts.

Classes were provided that moved between spontaneous and scientific concepts, encouraging a dialectic movement and promoting a functional reorganisation. What was learnt from previous intellectual activity was neither ignored nor discarded. It was rather rebuilt from previous generalisations, shaped in precedent levels, thus generating "genuine concepts", thus allowing students to achieve a deeper understanding of the content.

Previously shaped generalisations interfere with students' intellectual freedom. However, when intellectual freedom is acknowledged as the basis for competence in a specific domain, it increases, and a reflexive awareness that stems from "portals of scientific knowledge" is stimulated (Vygotsky 1934/2000, p.115), contributing to the personal development of the individual. Awareness enables the individual to understand the "how" of his actions and thus stimulates the establishment of new relationships (Fuga 2003).

Building upon the previously stated assumptions, this study combined different action-research techniques and attempted to establish a dialogue between the teacher/researcher and the group of indigenous students, in such a way that prior knowledge, culture and education could lead to a product in which all of those elements were valued.

Organizing and planning lectures as an action-research and teaching strategy benefits from considerable flexibility, allowing the development of contents throughout ordered stages, rather than in a rigid fashion. Given that indigenous students were from different ethnic groups, this procedure was very favourable because students liked to report facts they believed to be related to the content, as well as to discuss what was happening in their villages and with their people.

Because action-research is a form of experimentation in a real situation, in which researchers consciously intervene and participants play an active role, the variables are not considered isolated as all could interfere with what is being observed.

It should be noted that adopting action-research as an ethno-methodological research strategy also involves an interpretive approach in which the substantiality of the researcher is not total. Indeed, what the researcher observes and interprets is never completely separate from his previous training or experiences and involvement in the situation under observation.

In keeping with the principles of action-research, the classes followed the following order:

i. ***Exploratory stage*:** the class subject was proposed and a debate commenced on prior related knowledge (prior knowledge) to survey initial information. In general, students pointed out problems that occurred within their own reality (problems inherent to each village) and problems that were common to all (usually associated with environmental problems in the Amazon region).

ii. ***Problem identification*:** after the exploratory stage, a common problem was defined and a debate followed introducing theoretical contents and scientific terms.

The *analysis and delimitation of the initial situation* was set in the exploratory stage so that the focus of the lesson would not be lost; students were very eloquent when expressing their views and problems. This delimitation was achieved by presenting theoretical content concurrently to the interventions of students, thus accomplishing the *description of the situation*.

After this stage, practical observation activities (observations with magnifying glasses, permeability tests, etc.) were introduced involving the use of soil samples from different locations and mineralogical compositions (sandy soils, organic soils, clayed soils from different states of Brazil).

Thus, it was possible to identify the most common problems (to be addressed) that would engage the group in debate, action planning and presentation of ideas, through texts and other descriptive elements (drawings, diagrams, speeches, etc.).

The lecture proceedings

The lecture on soil included two parts: the group debate and practical activities. For the practical activities, the teacher/researcher provided mineral materials that were commonly used in villages and towns (such as cement, sand for construction purposes and topsoil sold for gardening), as well as soil samples from local sites and from the metropolitan region of São Paulo, with different colours and textures. The methodology used in the classroom was experimentation (Imbernon *et al.* 2009) and hands-on activities as described in Hamburger (2006).

In the debate group, some questions were proposed and students discussed these questions with each other. Finally, they reported the findings through texts, both in the native language, and Portuguese (Fig. 2).

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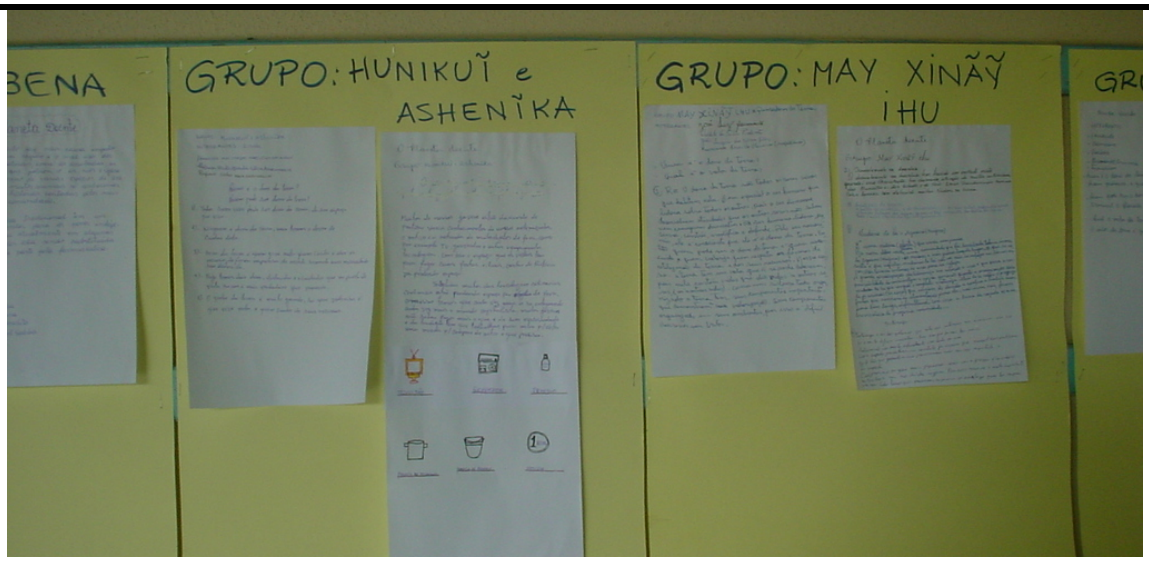

Fig. 2:Exposition of production of texts from group discussions

The teacher encouraged the students to use methods other than written texts to present their results, and drawings could also be used to represent the group's ideas.

First, the exploratory stage focused on the soil in the indigenous culture and life, based on the following questions:

What is soil?
How do soils form?
Are soils the same everywhere?
Do soils change?
Do I know how to use the soil?

The objective of this stage was to identify each student's existing knowledge related to an element of the environment deemed essential for their daily lives. Additionally, this stage aimed to counter that information with scientific (constructed) knowledge on terrestrial dynamics.

It should be noted that indigenous students focused on soil as an integrated element, situating it between physical environment processes and the biosphere. Indeed, when referring to the preparation of soil for agriculture, they reported the technique of "letting land rest" so that forest may revive from "worn out, tired soils".

It was very difficult for students to understand paedogenesis processes and the rock cycle. However, issues related to the processes of external dynamics, weathering and, to a certain degree, the relationship between these and the formation of soils, were addressed and understood.

Building upon comments and answers gathered during the exploratory phase, the students where then asked to address new issues, more closely related to the daily life of the village.

What is the soil like where I live?
How can we use soil for preserving life?
How do we use and occupy the land in the village?

Students were organised into groups and asked to describe the soil in the region of their villages, characterizing features such as colour, appearance and texture. They were also asked to include information related to the use and occupation of the land. The main observations are summarised in Table 5.

The answers given by the different groups presented a very similar description of soils and flat topography, and showed a lack of knowledge on the pedogenesic processes. When using terms such as "sand" and "clay", students did not refer to granulometry but rather to the different uses given to soil, such as planting, ceramic industry and furnace construction.

The terms "rock" and "soil" were presented during the class in the context of the processes of soil formation (pedogenesis), transport and deposition of sediments, and processes of formation of igneous and metamorphic rocks (the rock cycle). Most students reported never having learned this information. As such, different rock samples were presented, so students could observe their characteristics. Building up from these examples we then illustrated the rock cycle.

After the debate, practical activities were organised and each group was given samples of materials of mineral origin (cement, topsoil), local soil samples and soil samples from the basin of São Paulo, south-eastern Brazil. Magnifying glasses and containers (for handling the samples with water) were also provided. Students were asked to handle the samples and to describe their impressions of each material (Fig. 3).

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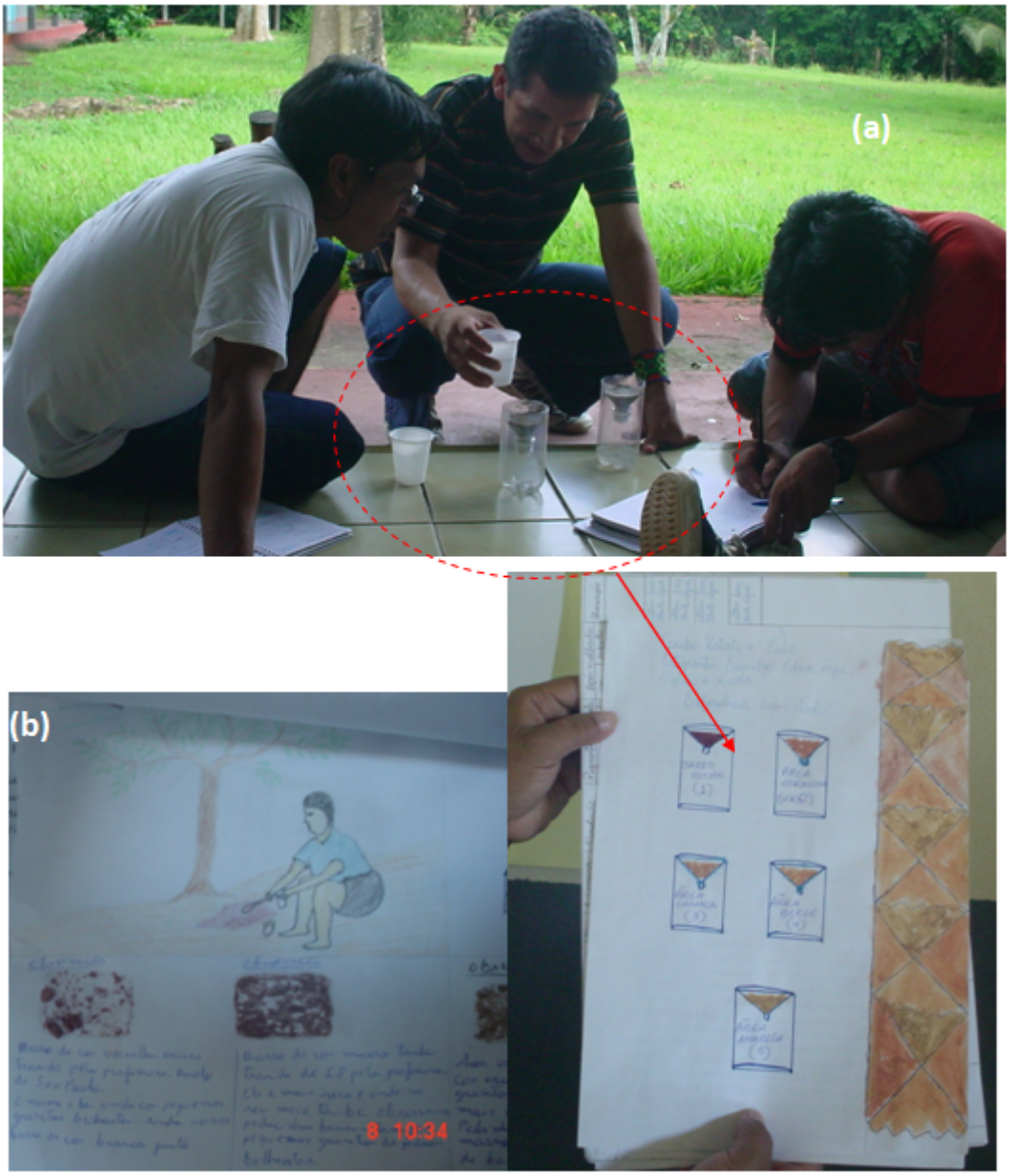

Fig. 3: (a) Indigenous students engaged in practical activities about soil permeability, (b) Drawn representations of the practical activities about soil permeability

Some students mentioned how impressive it felt to be able to observe "the brightness of soil pebbles". The main comments focused on the interaction between the soil and water that some students had observed in rivers and streams. During the experiment, some students reported that "the colour of the water in the stream remains the same when it rains and the "clay" blends into the river".

Although the researcher teacher provided material for drawings, indigenous students preferred to use the soil samples as "crayons". In fact, some groups used soil samples of different colours (especially red shades) to do *kene* (Fig. 4). When drawing *kene*, students explained its significance to their village life because *kene* is an artistic language of great importance among the indigenous peoples of the Amazon, and is considered part of their artistic and cultural heritage. The graphics known as *kene* are designated by the same word among various indigenous groups. *Kene* reflects history, memory and art, and each drawing has its own meaning. Usually, on ritual occasions, *kene* are painted in the body with ink of "jenipapo" (genipap) and in everyday objects such as ceramic ware and straw baskets (Oliveira et al. 2011).

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Fig. 4: Kene form as an artwork made by the indigenous students

Besides the production of artwork in the form of *kene*, students used the samples for modelling objects, and signalled that "the clay provided by the teacher was softer and better for this task" (Fig. 5). It should be noted that only female students participated in this modelling, as this conforms to the societal norms of the villages, in which ceramics is an activity conducted by women.

Fig. 5: Ceramics made by the female indigenous students using the soil samples in the practical activities

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Observations of the teacher/researcher

When the content of soil was approached, many questions arose, the main one referring to the term "rock". For the students, "rock" meant "the hard ground that lays beneath the softer soil of the surface, where planting occurs".

Indeed, the geological data for the state of Acre, in particular the region of Cruzeiro do Sul, indicated that the majority of soils in the state are of sedimentary origin (Bardalez et al. 2010). The origin of the soil in the state is related to the uplift of the Andes and alluvial sediments from the rivers, whose springs are located in the Andes region (Bardalez et al. 2010).

Some students identified an occurrence of "rocha sã" (fresh rock) in the region of Cruzeiro do Sul, near the Moa River, Serra do Divisor, referring to "the banks of the 'igaparés' (streams) near Moa", an area close to the villages of some students, have "pedra dura" (hard rock). Students who knew the area reported that this is the only place in which there are waterfalls. In addition, they mentioned that "the rocks there are very similar to the stones that the teacher showed in the class".

In the daily environment of the majority of the students, there were no sites with crystalline rocks. This hindered the theoretical presentation on the classification of rocks and the understanding of the processes associated with the rock cycle. Although the samples used in the class helped and the indigenous students were extremely observant of nature, they found it difficult to understand the genesis of each lithotype. Only half of the class completed this topic with an effective recognition of the geological processes and their interactions.

The eloquence of the students in the oral reports (transcribed by the teacher/researcher) was far greater than in their written texts, and showed the importance of the soil in the indigenous culture. Students of the Yawanawá ethnicity reported that whenever a burning takes place, before planting, they always take "the pregnant women of the group" with them, so that fire will not spread to the forest but rather remains restricted to that specific area.

A suggested topic/problem on the use of the land was related to planting and fertilisation. The reports stated that "fertilisers are drugs of the white man; for the Indian, when the soil gets tired, we make a new 'roçado' (clearing) and abandon the old one"; and when asked about how they recover the "tired soil": "... we leave the land on its own and the forest takes care of everything ... we let the forest grow back again, and then we can use the land once more, for it becomes strong".

The issue of farming productivity was explained by the relation between production and the demand for food supply (which are limited), with no need for artificial fertilisation.

Although not specifically related to the soil-related educational content, the issue of animal hunting was debated in relation to the laws of biodiversity protection in the Amazon region. Reports indicated that "only men hunt and women handle the meat". The objective of hunting is to provide the village with meat: "no one kills animals [needlessly], teacher, only to eat or for defence purposes".

III. CONCLUSIONS

Education involves emotional and relational issues that combine with the development of knowledge. Indeed, a society needs individuals with an understanding that goes beyond the formal knowledge of a school curricula—society needs individuals capable of applying that knowledge to difficult or sensitive situations. After all, the objective of school is to prepare the individual, enabling him to act and interact with the environment in a conscious and planned way.

Indigenous education in Brazil presents innovations, many of which emerged from the Organization of Indigenous Teachers of Acre (OPIAC). However, curriculum guidelines for indigenous higher education also observe methodologies and practices in the classroom repeating traditional models used in the schools of *nauás*. In this study, by adopting the methodological framework of action-research, the teacher aimed to find a point of congruence between students' knowledge and scientific knowledge.

Action-research as a methodological approach in the development of classes in CFDI, showed excellent results, especially in terms of generating a close relationship between researchers and participants when facing a representative situation or problem. In this case, "the teaching process" (action of the teacher/researcher) and "the learning process" (action of the indigenous students/participants) engaged all actors in a cooperative and participatory manner.

We identified two basic functions of the soil in the everyday life of the village: food supplies and ceramic manufacture. The soil showed some mineralogical characteristics favourable to each of these uses. Sandy soils are more suitable for agriculture, while claysoils are better for pottery and housing.

The description of the samples given to the students was based on these aspects. Although the terms "clay" or "silt" were introduced during classes, it was the use of the magnifying glass in experiments with water that allowed a better understanding of terms such as "coarse, medium and thin", as used to classify the "sands". Similarly, it was explained that the term *clay* (which students used) designated a material that had a greater amount of clay than of sand, and thus was moist and presented adequate

plasticity for moulding, as students demonstrated with the artefacts they produced in the classroom.

A respect for the knowledge that the students already possess is fundamental for the acquisition of new knowledge. Accordingly, the previous experiences and conceptions of each student, in each ethnic group, were a starting point for the introduction of the concept of soil and allowed a closer relationship between scientific knowledge and the indigenous culture, which is the traditional knowledge source of the students.

The theoretical framework that guided the interventions/classes applied intercultural knowledge to identify elements for the development of topics and content.

Therefore, learning and development are the essential factors without which we would not have the intended interaction between teacher and student, because the goal of the teacher varies in accordance with the significance with which he identifies themself.

For indigenous peoples, the school is a reconstruction instrument and affirmation of identities. The words spoken by the indigenous student Luis Yawanawá translate the relationship of indigenous peoples with soil for sustainable use: "…for white people (nauás) it is most important 'to be a land owner', to the indigenous peoples, it is important just 'to be'."

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