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Comics in Intercultural Science Education (ISE): Educational Innovation to Teach Ecology relating Peasant and Academic Knowledge

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Abstract

Intercultural science education requires a dialogue between knowledge systems, that configures a challenge due to the epistemic and ontological disparity between academic and local knowledge, one of the most important characteristics of the science education within local-peasant contexts is the way in which academic scientific knowledge is approached and linked with local knowledge into the classrooms. Based on the proposal of Intercultural Science Education (ISE) as a trading zone, this study. The perspective of trading zone in intercultural science education can function as a mediator between different epistemologies and ontologies if it is adequately engaged with both the empirical and philosophical complexity of bringing both Peasant Knowledge (PK) and Academic Knowledge (AK) into local classrooms.

Introduction

According to contemporary science education perspectives, it is recognized that providing quality science education to all students goes beyond simply imparting selected scientific theories. It involves engaging students in meaningful discussions and exploring "key facts" that have been reconstructed theoretically within the classroom setting. Students are encouraged to develop explanations that align with their existing knowledge and personal values. The role of teachers is to bridge the gap between students' existing mental models and the culturally significant models of science taught in school, which ultimately draw on the knowledge and practices of scientists (Amador-Rodríguez & Adúriz-Bravo, 2018).

Additionally, when talking about the objectives of science education El-Hani and Ludwig (2024), Molina-Andrade (2017), and Robles-Piñeros and collaborators (2020; 2023; 2024), affirms that a scientific education in Latin America must be culturally sensitive, and this process requires dialogic approaches, based on the dialogue in a bilateral way. Dialogue in the more basic sense is defined as the process through which different ideas are presented and explored, because arguments and presentation of reasons that give support the conclusions (Bohm, 1996; Buber, 2012). One of the principal roles of dialogue into the intercultural science education its offer to the students the capacity to take a conscious attitude towards the sciences, it´s uses, and the implications; allowing them, make a process of empowering their own issues and local situations, using science to find a better way to give answers to their daily questions (Baptista, 2012; 2018; Peñaloza et al., 2023).

Science teaching involves several key processes that aim to facilitate the learning and understanding of scientific concepts (Weil-Barais, 2001; El-Hani & Mortimer, 2007). Some of the fundamental processes in science teaching include Inquiry-Based Learning: Encouraging students to explore and investigate scientific phenomena through questioning, experimenting, and making observations. This process promotes critical thinking, problem-solving skills, and a deeper understanding of scientific principles (Harlen, 2013). Which is problematic in science teaching process and the cultural diversity, is not the representation of the scientific culture by the teachers, at the end of the day; teaching science is teaching scientific knowledge; but the privilege of an epistemic view of superiority of the science over

other knowledge systems it is (El-Hani & Ludwig, 2024; Robles-Piñeros et al. 2020). This knowledge, although to be present in the classroom, can´t be represented, because, in most cases they´re undervalued by the scholar culture itself and by the teacher, through the silencing of student´s voices (Kimmerer, 2012; Molina et al., 2014; Robles-Piñeros, 2023).

In addition, one point that emerge as relevant issue in intercultural science education is the educational materials and interventions used in the process (Hansson, 2018; Tovar-Galvis & Acher, 2021). To deal with cultural diversity it is necessary also have teaching materials and teaching-learning sequences designed and re-adapted to accomplish the intercultural educational aims, isn´t possible develop a culturally sensitive education process without appropriate resources and materials that allows an intercultural dialogue between these knowledge systems present into the school (Gallois & Reyes-Garcia, 2018; Santos et al., 2021).

Based on above, this article focusses on the process of community-based research, with a community-based philosophy (Ludwig & El-Hani, 2025) to design and develops a teaching-learning material to approach ecology in intercultural dialogue in two farming communities (Coração de Maria, and Retiro) in the state of Bahia in the northeast of Brazil. Section 1 Trace a framework to ecology teaching and intercultural science education, also describes the importance of the production of culturally sensitive didactical materials and develops the approaches to Intercultural Teaching-Learning Sequences (ITLS) in intercultural education. Section 2 Present the educational design research method and the use of contextual cognition tables to relate knowledge systems as methodology of the study. Section 3 Develops the idea of comic production as educational innovation to intercultural dialogue in science education. Section 4 Explores considerations for an intercultural science education and further directions in the research field.

Theoretical Framework

Intercultural Science Education as a Trading Zone

According to Robles-Piñeros and collaborators (2020), classrooms rarely conform to the ideals of non-hierarchical exchange between academic scholar knowledge and Cultural Knowledge from local-peasant communities. The concept of knowledge systems is always an abstraction of heterogeneous practices, and neither is fully integrated into classrooms. The incorporation of different parts of Local-Peasant Knowledge depends on heterogeneous factors, and a constant challenge to the marginalization of this knowledge is that it often only enters the classroom where it already overlaps with academic knowledge, in the sense that it is considered valid (or even useful) from academic perspectives (El-Hani, 2022; Peñaloza et al., 2023).

Further on this point, science classroom within the intercultural science education model becomes a trading zone, since in the process of teaching and learning sciences, dialogue between knowledge systems is promoted, but not only a dialogue but beyond that, a negotiation process between systems,

which leads to an encounter between knowledge, realities and values (Robles-Piñeros et al., 2024). Thinking about classrooms trading zones does not only help to understand the (often highly politicized) structure of negotiation processes but also spaces for educational interventions that can reconfigure processes of knowledge incorporation.

In the broadest sense, when referring to the trading zone in intercultural science education, the need to broaden the dialogue is recognized, not only to the purely epistemic questions of the process, but also to those related to the ontological commitments and values that emerge from this knowledge in different communities; since this is how an education sensitive to this cultural diversity is promoted, one that tries not to favour hierarchical models and defends horizontalization in the approach to knowledge systems (Robles-Piñeros et al., 2023). Thinking of trading zones as spaces for epistemically productive exchange complements the idea of overlaps between knowledge systems. However, recognition of the partiality of such overlaps can also help to avoid a naive characterization of trading zones as harmonious places of mutually beneficial intellectual exchange. Trade is not always successful. It is not always mutually beneficial (Robles-Piñeros et al., 2020).

Teaching Ecology in Intercultural Science Education

In the intercultural project, local knowledge (indigenous, peasant) perspectives extend and enrich the educational experience, they provide intercultural knowledge and experiences and afford opportunities to explore and appreciate local socio-cultural, economic and ecological contributions to society (Evering, 2012; Peñaloza et al., 2023; Robles-Piñeros & Abella, 2024). The accumulated ecological knowledge of the local and traditional groups around the world represents a body of thoughts, experiences and actions (ontological commitments), and those characteristics, must be honoured and preserved as a vital storehouse of environmental wisdom (El-Hani & Bandeira, 2008; El-Hani & Ludwig, 2024; Kimmerer, 2012). Modern societies must recapture the ecologically sustainable orientation that has long been absent from its psychological and social consciousness (Beckford & Nahdee, 2011, Ludwig et al., 2024; Ludwig & El-Hani, 2025).

In the field of education, is usual to find educators unaccustomed (or usually unprepared) to teach sciences (biology or ecology) making a relational process between knowledge systems (Baptista & El Hani, 2009; Molina et al., 2014; Robles-Piñeros et al., 2023), this phenomenon may seem intimidating when they try to be infusing this intercultural process with non-scientific knowledge perspectives. However, teachers need not be steep in knowledge of contextual and local perspectives to start incorporating them into classroom practice (El-Hani & Ludwig, 2024), recognizing and valuing can be a relevant point. Local and indigenous peoples' relationships to their land represent models for human interaction with nature taught through education, these can help change the negative attitudes toward environmental quality. Local Knowledge are relevant in mainstream education and could be incorporate into science education in Global South countries (Peñaloza et al. 2024; Robles-Piñeros, 2023).

This kind of approach aimed to develop a rich knowledge based and multifaceted beliefs and/or philosophies about the environment, which lead to ecological sustainability. Teaching ecology in local context focuses on local student's ability to give a relevant interpretation of their daily context as an ecosystem, based on recognition of common organisms and awareness of their autecology together with an understanding of the relationships between these organisms and how abiotic factors influence too in the whole environment (Robles-Piñeros & Abella, 2021). Teaching should be including ecological systems and processes, in their integration with social processes, making use of socio-scientific and socio-environmental issues (Robles-Piñeros & Tateo, 2023), this non-recognition had motivated multiple alterations on the fragile balance of the natural processes, through the exploitation of natural resources and the not-application of a production way based on renewable resources, besides the expansionist march of the savage capitalist economy which had taking place since the industrial revolution.

However, in that process gives a wider panorama to select and choose the structural concepts and principal models in ecology that will be use into the classroom. These fundamental principles could be the basic approach to make a proposal of science teaching in local context, guided by the need of teach a series of contents that allows to the students to develop the capacity of read the nature as an important aspect of the ecological literacy (Magntorn & Hellden, 2006; Abella & Garcia-Martinez, 2024).

Educational Innovation: Culturally sensitive teaching materials

Nowadays, in schools is fundamental to reflect on the importance and transcendence of a contextual and meaningful education, due it is a cultural event basic without which it´s not possible to understand society and culture (Weinstein, 2006). Is important to enforce the process of science teaching into the school and specifically of ecology, under the base to understand how science explains the actual social and environmental problematics and giving the chance to dialogue with another knowledge systems providing the opportunity to students and teachers to discuss about the convergence or divergence between knowledge and practices.

One of the principal challenges in the science teaching process in different educational levels, and contexts it's the lack of motivation and interest toward the different thematic presented by the teacher in the science class (Negrete, 2013). It´s difficult to carry out the teaching into the classroom, and moreover into local contexts; then, it is then necessary (and desirable) that a culturally sensitive science educator innovates and transform how it carries out the educational process directed towards the students (Kaur, 2011; Robles-Piñeros et al., 2018, Rota & Izquierdo, 2013). The generation of possibilities into the science classroom to students enlarges their conceptions with scientific ideas through the dialogue, certainly does not need just the previous ideas researching, but also need of didactical resources that facilitate the process, being important the production of these kind of materials based on the realities of school, the local context and the classroom (Baptista, 2012, Robles-Piñeros, 2023).

Into the daily language of each person, there are symbols, images and messages, wherever they look, humans as primates with visual characteristics distinctly, present more proclivities to welcome and

show more interest for what attracts their attention at a visual level (Londero, 2014). “A picture is worth a thousand words[1]”, the proposal of the use of comic as didactical resource to teach science is a good tool to use in the process of science teaching into the classroom (Tatalovic, 2013, Robles-Piñeros, 2013). Being the comic a tool of graphic nature, foster student curiosity through images and stories that catch their attention, and then, their interest level by the thematic taught increase considerably, allowing an approach to the concepts that are intended to teach based on the motivation and curiosity that the student has (Rota & Izquierdo, 2003). Moreover, the narrative nature of comics could be combining reality and imagination to tell and to explain natural phenomenon and relate with daily situations making a more sensitive process in science education.

In the communication era, information is within reach of any subject, for this the comic offers an interesting approaching way to science (Moix, 2010), showing the science in a view that introduces the reader into the history and it turns in a part of their own experience (Cheesman, 2006; Weistein, 2006). A didactical resource in comic format with a great connotative charge is a great resource in science teaching (Negrete, 2013). Thus, if the conduct of social dialogue takes place around meanings, the relationship of the I with the You (Buber, 2012), it becomes necessary for the teacher to investigate what pre-school knowledge students have so that it is possible to adapt teaching and learning strategies that are dialogic.

Intercultural Teaching-Learning Sequences (ITLS) for Science Education

In science education, proposals have arisen that advocate for purposes and objectives different from the traditional ones, that is, for those that are related to a functional teaching that enables the student to cope with the current demands of society (MeHeut & Psillos, 2009). When analysing the evolution of Biological Sciences, Meirink and collaborators (2010), argues that it is necessary to possess functional and integrated biological knowledge that allows degrees of reflection in the socio-natural context and in the face of real problems. In this way, he is in favour of a biological scientific literacy, establishing some priorities for the teaching of this discipline.

We will understand as a Teaching and Learning Sequence (TLS) the set of activities organized and systematized to address and solve a scientific problem at curricular level (Izquierdo-Aymerich et al., 2016). Therefore, it is a way of planning and designing the teaching and learning process (Méheut, 2004), which is why it includes answers to questions such as: what specific content, in what context, with what objectives, in what order and how each of the activities carried out to teach and learn the subject or the contents covered is carried out and evaluated (Merino et al., 2015). However, it is important to note that most of these TLS proposals are made for formal educational contexts and do not consider cultural diversity; therefore, it is necessary to include the intercultural perspective in the development of these teaching sequences.

According to Robles-Piñeros and collaborators (2024) one particularity of Intercultural Teaching-Learning Sequences (ITLS) the process of proposal, design, and construction of activities and materials must be oriented by the need to promote intercultural dialogue, this is a very relevant and point in this proposal. Under the perspective of intercultural dialogue, the ITLS must be re-adapted to not only approach scientific knowledge but make relation with traditional ecological knowledge from the community (Robles-Piñeros et al., 2023; 2024). Based on this, was took and re-designed the model of didactical rhombus proposed by Méheut and Psillos (2004) to introduce Cultural Knowledge from Teachers and participants and the Peasant Knowledge from the community (Fig. 1), with this re-approach it is granted the possibility to relate both, epistemic dimension and pedagogical dimension with Cultural and Academic Ecological Knowledge with Peasant Ecological Knowledge in an exercise of double-via dialogue.

This figure representation allows organizing various considerations that can play when designing an ITLS. The vertical axis represents an epistemic dimension, i.e. how knowledge works with respect to the material world (natural phenomena). Along this axis, we can find assumptions about nature of science, such as: Contexts; Correspondence; Evolution; Intervention; Judgment; Languages; Methodologies; Rationality; Representation; Values. The horizontal axis represents the science education dimension. We find along this axis choices about a teacher's role, types of interactions between teacher and students, and close to the vertex "students", we can place what is expected about interactions among students. Using this framework, we can characterize two prototypical approaches in designing teaching-learning sequences.

Methods

The research corresponds with the symbolic interactionism paradigm (Serpe & Stryker, 2011) combined with educational qualitative approach, this allows to make an analysis of the immediate situation of participants and promote educative actions to improve teaching process in the context itself (Creswell, 2010; Devetak et.al, 2010). Complementarily, this work has an ethnographic focus, based on the principle of Participant Observation (Kawulich, 2005), in which researchers and teachers participate in school activities, as well as the students, to avoid what Wacquant (2002) calls "ecological paralogism", when the presence of the researcher interferes in the behaviour of research participants, who fail to act as they routinely do.

Participants, Context and Ethics

Study was carried in two farmer schools from two villages form the Northeast of Brazil within the development of PhD research carried out by the first author. These schools are characterized by the presence of farmer students that came from near villages around the town, and many students alternate their studies with a job as a farmer. For that reason, it was identified the need to develop a kind of ecology teaching that responds to the Coração de Maria´s farmer student's reality, giving a contextual

and historical approach to the concepts of ecology, to treat the problematic of crop pests into the farmer population.

The study was designed with transdisciplinary-participatory research under the perspective of educational design research, in the sense that decisions and planning were developed in a collaborative group that involved three (3) researchers, four (4) in-service science teacher and the participation of thirty (33) students and their families. This work has approbation and protection by the ethics committee of the State University of Feira de Santana, under resolution CONSEPE (Conselho Superior de Ensino Pesquisa e Extensão) n. 097–2018.

Procedure and Strategy

- First at all were planned meetings between researchers and teachers to create an Intercultural Practice Community (Orjuela-Osorio, 2023); as non-hierarchical group aimed to discuss about the objectives of intercultural science education, scientific literature of ecology teaching, analyse the ecological contents present in the textbooks and as an important part of this kind of methodological research were taken and used the experiential knowledge form the daily labour of each teacher, and the Peasant Ecological Knowledge from students and community as a whole.
- Secondly were choose the educational design research as methodological perspective, because it offers an adequate way to propose research issues about the production and improvement of educational innovations (didactical sequences or didactical resources (Plomp, 2009). This modality of educational investigation includes a variety of methodological approaches (Nieveen et al., 2006), that aims not just to produce educative innovations but enlarge the knowledge about the planning and implementing the process of those interventions and their characteristics, called principles of design.
- Third, peasant knowledge was obtained through visits and conversations with the students and their families, these dialogues were transcript and codified, systematized and analysed by descriptive coding (Saldaña, 2013) and then obtain general categories of Peasant Ecological Knowledge (PEK). And, after this process were used the model of Contextual Cognition Tables proposed by Baptista (2018) to establish relationships between this knowledge and the academic ecological knowledge, whether of similarities or differences in ontological and epistemological terms.
- And for last, were proposed a script, and story to produce an intercultural teaching material in comic format to promote dialogue between knowledge systems, in which dialogue was promoted between the structuring concepts of school ecology and the knowledge derived from the agricultural practices of the families to which the students belonged. It is important to mention that because the process is done from the intercultural community of practice, the script, the characters, the cases of the community's agricultural practices, and the ecological concepts that were selected were discussed and approved by all participants of the community of practice: researchers, teachers, students, and some parent representatives.

Results and Discussion

Due to the nature of the research presented above the results are shown in three dimensions attending to the collaborative co-production issue: First, the design principles to produce an Intercultural Teaching-Learning Sequence to teach ecology in peasant context. Second, introduce the Contextual Cognition Tables because of a participatory exercise with teachers, students and their families relating Peasant Knowledge (PK) and Academic Knowledge (AK); and third, a didactical resource in comic format relating PK from the community with AK.

1. Design Principles to Produce an ITLS to teach ecology in a farmer context

Planning process of this educational intervention was product of the near relationship based on dialogue between the researchers and teachers, were treated and analysed the teacher´s worries about teach ecology in intercultural way, it means, make an approach to the contents of ecology using the daily life of students, to make a meaningful process and a meaning trading between knowledge systems into the classroom. Based on that pedagogical restlessness were defined a kind of guiding topics to develop the intervention, these topics were taken as design principles. Those principles were formulated using as basis (1) the experiential teacher´s knowledge and (2) specialized literature in ecology teaching, intercultural education and didactical resources production and (3) the Peasant Ecological Knowledge from community.

As a result, were constructed three principles:

(I). Promote within the students the opportunity of applying and use the ecological knowledge in their daily life, interpreting and analysing quotidian situations and problematics where the knowledge of ecological relationships, or biotic-abiotic dynamics could give an answer.

(II). Use the intercultural dialogue perspectives to produce a resource that can approach the scientific concepts of ecology in a dialogical relation with the daily language of students and their entomological-ecological peasant knowledge.

(III). Provide an approaching resource in comic format as strategy to teach ecology in a farmer context that respond to the need of make a socio-cultural contextualized teaching process.

The design principles can be expressed in heuristic enunciate that guide the selection and application of knowledge to specific tasks of planning and developing of educational interventions. This knowledge could be from substantive nature and a procedural nature; the first one is the knowledge about the characteristics of the interventions, which could be extracted from the results of the intervention itself. In addition, the second, and the procedural nature, are the group of activities that will be considered as the best in the process of the intervention development (Plomp, 2009). The principal aim is to formulate those principles that constitute enunciations that guide other educators in the development and application of this or other educational interventions about the same thematic or in a similar educational context (Sepulveda et al. 2016).

Then were designed an ITLS identifying points of dialogue between ecology and cultural practices during teaching. The planning process of this educational activity was facilitated through a close relationship between the researcher and the teachers that involved discussion of pedagogical approaches to contextualized ecology teaching and its embedding in concrete cases from daily farming practices.

"*Bringing ethnoecology to the classroom*", was the general motto used to call the ITLS proposal promoting the trading zone model on intercultural science education, this intervention led to a dialogue that addressed ecological learning contents through daily peasant situations of the students. The ITLS application took place in the two schools and aimed to address core concepts from ecology based on the design principles previously formulated, was choose contents such as the notion of ecological relationships, energy flows, ecosystems, trophic networks and two important but less used concepts complexity and resilience. This selection of concepts was made together with the science teachers and considering the curricular guidelines.

The first exercise focused on ecological relations using as models' insects of agricultural importance that students and farmers recognized from daily experience. For example, using the famous caterpillars (lagarta de fogo e do milho) was possible to approach the concepts of concepts of predation, mutualism, and parasitism. The activity focused on approach concrete instantiations from the immediate environment of the students to understand an abstract concept like ecological relations. Hoping with this training in the students the ability to identify and recognize the model organisms (insects) and themselves as an important part of the flow of energy, ecosystem interactions and introducing the idea of diversity and complexity in ecosystems (Magntorn & Hellden, 2006; Robles-Piñeros & Tateo, 2023).

As a second exercise focusses on the construction Contextual Cognition Tables (CCT) with teachers and students. This method seeks to analyse relations between knowledge systems to find points of convergence and divergence. Using three columns, contextual cognition tables allow to establish links between students' and farmers cultural knowledge, contents of ecology's teaching, and scientific content from the scientific literature.

2. Tables of Contextual Cognition to relate PK and AK

This Contextual Cognition Table was constructed in a collaborative work between researcher and teachers using: i). Peasant Knowledge from students and farmers from the community, ii). Contents from the three principal textbooks often used in the science class: Biologia e Contexto (Amabis and Marho, 2016); Biologia hoje (Linhares & Gewandsznajder, 2014) and Bio (Lopes & Rosso, 2013), and iii). Clippings of scientific literature in entomology and agricultural topics.

The systematization of the information was made by coding names with and E letter and a number to identify the subject and to respect their identity based on the model of descriptive coding proposed by Saldaña (2013). This method has as principal objective to put in terms of horizontality three perspectives in knowledge systems: Peasant Knowledge (PK) from community, academic content from textbooks,

and content of scientific literature; hoping with this support the teachers in the process of “trading” between Academic and Peasant Knowledge (Robles-Piñeros et al., 2020).

Table 1
Contextual Cognition Tables: relations between Students' Peasant Knowledge (PEK), Contents of biology (ecology) teaching and Contents of the scientific literature as proposed by Baptista (2018) to relate knowledge systems.

Community Peasant Knowledge	**Contents of Biology Textbooks**	**Contents of Scientific Literature**
The fly when sits in the orange plant, there lays their eggs, then this fungus that fungus causes the orange to turn black. (E3).	Some insects affect the plants in a parasitic relationship, some of them named as miners; they get into the plant and then develop into (Amabis & Martho, 2016).	There exist plant miner insects that live and feed on the epidermis of the plant. Can be leaf miners, which live between the two epidermises of a leaf and stem miners, staying in the superficial levels of the stem. Only four orders of Holometabolous (insects that suffer complete metamorphosis) are miners: Diptera, Lepidoptera, Coleoptera, and Hymenoptera (Borror & White, 1970).
We have problems with the caterpillars, when they appear then everything keeps "with bugs" (E6)	The caterpillars such as "the silkworm" *Bombyx mori*, can measure up to 5cm long and can have a devastating impact on cultivated plants (Lopes & Rosso, 2013).	The caterpillars pierce the leaves of the plants to feed themselves. The most aggressive when they appear destroy the foliage. There are others that cut the apical tissue of the developing seedlings, preventing them from growing. Other caterpillars known as "broca" drill and penetrate the fruits such as tomatoes, cucumbers and ahuyamas etc. Once the drill bits penetrate the fruits are very difficult to control and the fruits attacked are unusable. (Wuatanabe y Melo, 2006).
With the beans, for example, the leaves were all pierced, I don´t know, I forget the name of insect right now, but I know that is a small one that enters the leaf and eats it, my grandmother applies a remedy to attack them (E8).	Some insects cause damage to plants, some can eat leaves and other stems and roots [...] The fight against insects and other organisms that destroy plantations is mainly done with agrotoxins and agricultural defensives (Linhares & Gewandsznajder, 2014).	Insect miners belonging to the orders Coleóptera, Lepidóptera, Díptera and Himenóptera are herbivores specialized in feeding on the internal tissue of the leaf. The larvae of the mining insects remain in the mesenchyme throughout their development phase. As the larva goes feeding, they form a tunnel (mine) that is printed on the surface of the leaf. (Gillot, 2005).
The ants, the cutter ants ... they are, the plants when they are growing, the ants take the feet of the little plants and carry them with them underground (E10).	Among many species of ants, the leaf-cutting ant (*Atta sp*.) Is perhaps the best known, because it causes damage to crops, these ants are known as cutters because with their jaws they cut and carry the leaves of the plants (Amabis & Martho, 2016)	Leaf-cutter ants are social insects that have breeding and non-breeding castes living in permanent colonies. They are the main pests of the crops, since they intensely attack the plants at any stage of their development, cutting their leaves, flowers, buds, and stems, which are taken to the inside of their nests under the ground, which makes it difficult to control them. (Zanetti, et al. 2002).
I know that the insect most problematic are the caterpillars, then the others not that much […]	Grasshoppers (about 5 cm in size) are known as voracious herbivores and can be quite harmful to the	Among the insects that most affect crops, are representatives of the orders Orthoptera, Hemiptera, Coleoptera and Hymenoptera and within the latter,

Community Peasant Knowledge	Contents of Biology Textbooks	Contents of Scientific Literature
And the grasshoppers, Crickets, and ants, all those we kill, had a near relationship with the plants that we cultivate, those insects are parasites (E4).	plant from which they feed. (Linhares & Gewandsznajder, 2014).	representatives of the Formicidae family. (Picanço, 2010).
There are alike fly's insects… Let me see… there is a fungus that they are very small, it´s not easy to see, they are whiteness and are glued to the plant and you can´t remove them, then the plant keeps dark (E12).	Some plants are affected by different types of threats, which can be insects, fungi, viruses and bacteria, which can affect the development of the plant and its survival. (Linhares & Gewandsznajder, 2014).	Two species of Coccidae of the genus *Parthenolecanium* are considered pests of beans, are known as *Parthenolecanium persicae* (Fabricius, 1776) and *Parthenolecanium corni* (Bouché, 1844) Hemiptera: Coccidae. The easiest way to differentiate them is based on the biological characteristics, being that *P. persicae* has only one generation per year and three nymphal stages. (Afonso, 2004)

By analysing the results showed in Contextual Cognition Table (Table 1), it is possible to identify that the knowledge of community allows an intercultural dialogue, it is possible to find a lot of convergences between knowledge systems and brings opportunities to approach scientific knowledge to daily situations of the peasant community. As example, one concept that can be approached in contextual teaching within an intercultural dialogue is the concept of trophic web, because it was possible to evidence that students and their parents recognize a type of feeding (preying) relationships between organisms within their crops, in addition, this concept is a structuring concept in ecology theory and teaching (Aguilar, 2012, Paprotna, 1998; Picket et al., 2007).

The peasant knowledge can be very useful to the teachers when they are teaching sciences (ecology) in culturally diverse context, indeed observing the table is possible to find socio-environmental situations that promotes the possibility to identify tensions between knowledge systems (Ludwig, 2016; Robles-Piñeros, 2023; El-Hani & Ludwig, 2024) when students declares that they don´t know the name that science uses, but they call in some type of ethnoclassification. This aspect is a clear opportunity to the teacher to "deal" meanings with the students showing that his/her knowledge system can be related with academic ecological knowledge in a form of dialogue (Santos et al., 2021; Robles-Piñeros & Abella, 2024).

Such relations can significantly contribute to dialogues in science classrooms. The exercise turned out to be mutually enriching for the students because they were able to recognize the importance of their local knowledge and its cultural value and for the teachers as it broadened their pedagogical resources in culturally sensitive science education that locates spaces for dialogue (Peñaloza et al. 2023; Robles-Piñeros et al., 2023). This result brings the foundations to produce an intercultural resource, then the next step was the production of an educational innovation in a comic format.

3. An intercultural resource to relate Peasant and Academic Knowledge: Zé e os Bichos (Zé and the Bugs)

At last, was developed (proposed, designed, and published) and educative innovation in comic format, this proposal seeks to make a contextual approach to core concepts of ecology (which were previously selected by the collaborative group), socio-environmental issues of the community related with insects with agricultural relevance, agroecology and Peasant Knowledge as relational axis in a comic book. The narrative and the story were created by the teachers, students and parents proposing a young hero[2] from the region, named "Zé" (a diminutive form of the name Jose), who is a student at Coração de Maria´s village and a resident too.

In this story it is possible to travel through the reality of the agricultural world of the villages; and introduces the reader to the world of ecological relationships, approaching the reality of farmers, their Peasant Knowledge (Fig. 4-A) and the search for a relationship of dialogue with the contents of ecology (Fig. 4-B). The whole didactical resource could be downloaded from the Federal University of Bahia repository in this link: https://repositorio.ufba.br/handle/ri/34698.

It is important to highlight that in the comic it is possible to demonstrate a process of trading zone between PK and AK through the use of crop care practices and concepts of modern agroecology, which allows us to find aspects of convergence between these two, and on the other hand, differences between the names that the community gives to some organisms and the scientific names, which becomes an opportunity for dialogue between knowledge systems.

Also, as shown in Fig. 4B, when the student comments that in his family they say that the "soil gets tired" and therefore it is necessary to take measures with crop rotation, the teacher mentions that saying that the soil gets tired in science is called nutrient loss and is due to the nitrogen cycle, introducing here a dialogue between knowledge from a horizontal and non-hierarchical perspective that accounts for the importance of recognizing the way in which communities produce and validate their ways of knowing. This resource was used by the science teachers of the two schools in the ITLS application process to relate and dialogue between the PK and AK in their teaching practices, thus promoting an approach to the concepts of ecology from a lived, personal perspective that addresses the epistemological, ontological, and value issues of the communities for which the comic is intended.

Discussion

Teach ecology using a comic in intercultural way under the model of trading zone, seeks attention of student through the innate visual tendency that human owns, due, more than just only seek their attention and give them a motivation to read. This resource searches the development of not only attitudes and favourable behaviour to nature conservation but valuing and promoting self-recognition of their cultural baggage. This kind of resource, aim to re-significate the form in what ecology is taught in culturally diverse contexts, proposing alternative ways in the design and production of different didactical strategies; so that in this way, the process of science teaching take a meaningful role in the

peasant experience of students and community. Since this is the only way to achieve a successful ecological literacy process that is committed to the epistemological and ontological aspects of the participants in the educational process (El-Hani & Ludwig, 2024; Robles-Piñeros & Abella, 2024;).

This educational innovation tries to teach the importance of learn about the ecological processes and an important issue in agriculture as the biological control of insects with agricultural importance. With this kind of approach, we hope to promote a better way to teach ecology in local contexts, using the daily life and issues of farmer students and put them in the academic language, using the intercultural dialogue. But one issue worth noting is that for students, the practices and classifications of the PK are not abstract bodies of knowledge but intimately linked to their daily life and informal practices of knowledge transmission in the family context (Fig. 4-B).

From the point of view of intercultural science education, this situation raises complex questions about the potential synergies between formal schooling and informal transmission of Peasant Knowledge, as well as strategies for navigating the tensions between knowledge systems. It is not about teaching ecology as a subject isolated from other areas or from biology itself, or as a curricular individuality, but something more fundamental: it is about placing ecology and Earth systems at the centre of life and at the centre of life of the subjects (Robles-Piñeros & Tateo, 2021; Abella & Garcia-Martinez, 2023); without losing sight of the value and importance of the communities' traditional knowledge, it is a matter of emphasis rather than content, of centralizing what is most important (Beckford & Nahdee, 2011; El-Hani & Ludwig, 2024).

Conclusions and Further Directions

By seeking to investigate and understand Peasant Knowledge (PK), establishing relationships with Academic Knowledge (AEK), teachers will be promoting expansion spaces for students with scientific knowledge, to develop scientific (and ecological) literacy and in decision-making, where scientific knowledge can be useful when convenient or appropriate without losing sight of the importance and value of their own knowledge.

The proposal is to promote opportunities, with alternative materials and procedures, but contextualized and sensitive to the context, where the teacher makes a dialogue between students' knowledge and scientific knowledge. It is therefore necessary to develop educational processes that go beyond the utilitarian perspective of the PK at the service of the AK and to think of science education as a process that is concerned with the epistemological and ontological commitments of the participants in the educational process (teachers, students and communities).

It should be noted that in this type of approach, there is a limitation to obtain broader generalizations or application in other educational contexts, as the construction of principles and the production of the didactic resource were produced in a particular and specific context; however, this experience can be taken to other contexts, making a necessary process of contextualization and respective modification in response to the needs of the context and the population. However, this study could probably be an

adequate reference for the process of training culturally sensitive science teachers in Brazil and Latin America.

Certainly, the dialogue between knowledge systems will contribute so that students can represent their cultures, specifically individuals who had different cultural origins from the Western model of life and the focus of science that has been taught, usually those from rural areas. We know that in the teaching of science and ecology, current scientific models or theories are used, but this knowledge is not enough to teach in context. We have proposed also including cultural knowledge as a theoretical and methodological source for the design. of teaching-learning sequences with context for students, guiding aspects and with power for this research.

Declarations

The authors have no competing interests to declare that are relevant to the content of this article.

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Author Contribution

JRP: Conceptualization, Investigation, Writing - original draft.RYAR: Methodology, review, and editing. GCSB: Supervision, Project administration, review and editing. AMA:Supervision, Writing - review and editing.

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Data Availability

The datasets analysed during the current study are available from the corresponding author on reasonable request.

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Footnotes

1. This phrase emerged in the USA in the early part of the 20th century. Its introduction is widely attributed to Frederick R. Barnard, who published a piece commending the effectiveness of graphics in advertising with the title "One look is worth a thousand words", based on a Chinese proverb: “One picture is worth ten thousand words”.
2. The semantic category of “hero” into the modern conception of that, have a different approach to the classical connotation of the “superhero”, to Umberto Eco (1981), the concept of contemporary hero doesn’t need to have superpowers, or be a supernatural character, in the new conception of hero are the ethical and moral charging. However, this responsibility is carried and materialized in daily characters, who represent the power of the individual Moix (2010).

Figures

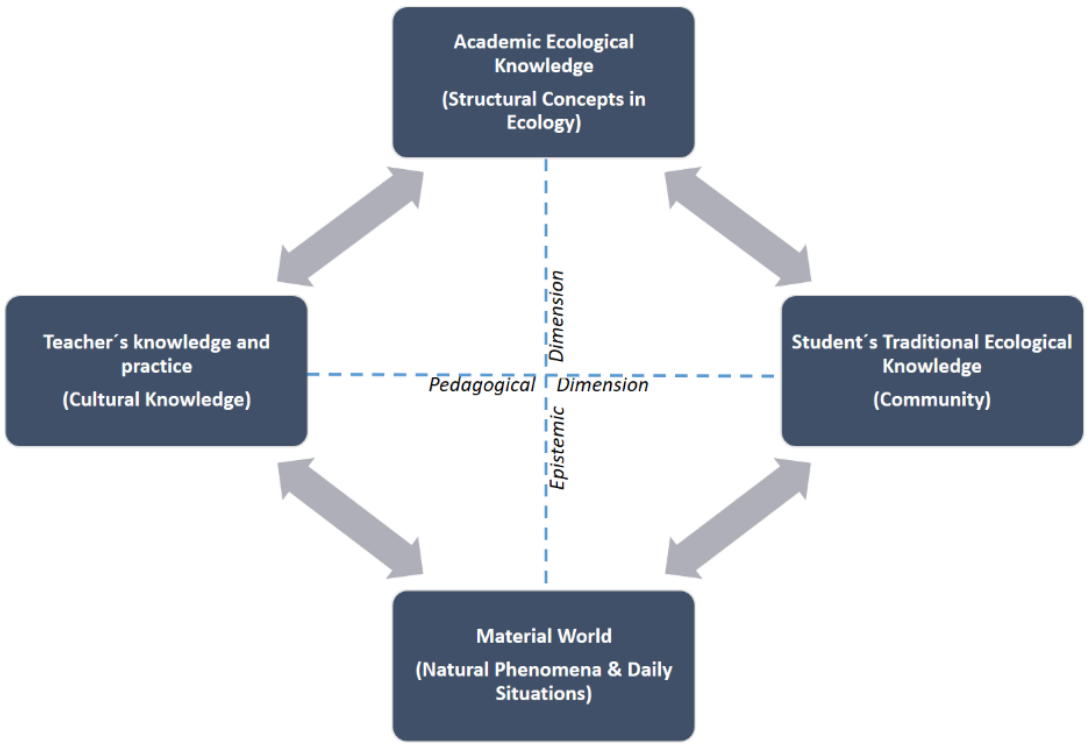


Figure 1

Re-approach of Méheut and Psillos rombus to Teaching-Learning Sequences (TLS) adapted to the proposal of Intercultural Teaching-Learning Sequences (ITLS).

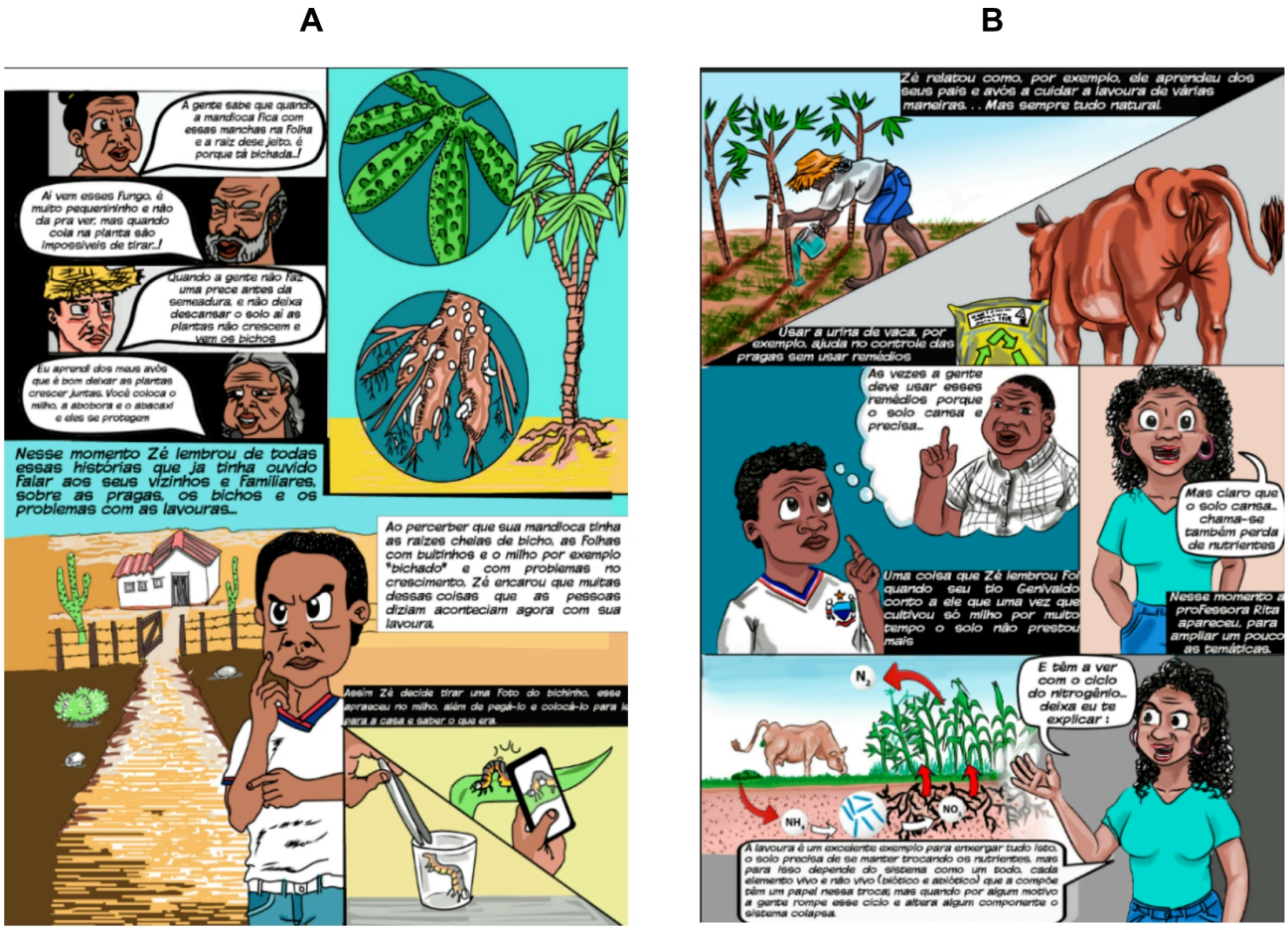


Figure 2

Figure 4. Comic book pages, A). Presentation of the TEK, where it´s possible to find excerpts taken from the speeches of farmers of the region about the problems with their crops; B). Relation between PK and AK, where opportunities for dialogue between knowledge systems such as “soil that tires” and nutrient loss are found.