

THEMATIC SECTION: FAUNA, FLORA, OTHER  
LIVING BEINGS AND ENVIRONMENTS IN  
SCIENCE AND BIOLOGY EDUCATION



## Zoology, Environment and Society in Preservice Teacher Education

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**ABSTRACT – Zoology, Environment and Society in Preservice Teacher Education.** To contribute to the field of didactic planning and expand knowledge and approaches to new ways of understanding, narrating, and constituting the natural world regarding fauna, one present this investigation on teaching-learning sequences produced by preservice science and biology teachers. This article discusses teaching-learning sequences whose core activities converge towards the development of knowledge that integrate aspects of zoology, environment, and society. The main proposals, possibilities and limits based on the following themes are analyzed: anthropomorphization; traditional knowledge, aesthetics, and animal resources; zoos, collection, and animal ethics.

**Keywords: Didactic Planning. Teacher Training. Zoology.**

**RESUMO – Zoologia, Ambiente e Sociedade no Planejamento Didático da Formação Inicial.** Com o intuito de colaborar para o campo do planejamento didático e trazer elementos para ampliar os conhecimentos e abordagens de novos modos de entender, de narrar e de constituir o mundo natural no que concerne à fauna, apresenta-se esta investigação sobre sequências didáticas produzidos na formação inicial de professores de ciências e biologia. Discute-se, neste artigo, sequências didáticas cujo cerne das atividades convergem para a elaboração de conhecimentos que integram aspectos sobre zoologia, ambiente e sociedade. Analisa-se as principais propostas, possibilidades e limites a partir dos seguintes temas: antropomorfização; saberes tradicionais, estética e recursos animais; zoológicos, coleta e ética animal.

**Palavras-chave: Formação de Professores. Sequências Didáticas. Zoologia.**

## Restoring zoology teaching in Basic Education

Knowledge<sup>1</sup> of fauna dates to the most ancient human thoughts and actions, as it is possible to note when appreciating rock art – elementary pictorial representations that, imbued with art and symbolism, record the human populations' way of life, but are also legitimate ancestral marks of animal identity, way of life, and biological diversity (Alves, 2012, Da-Silva; Coelho, 2016). In a more systematic way, zoology consolidates itself as a work activity, in Contemporary Europe, as a branch of Natural History, a scientific activity that sought to gather and catalog everything that existed in nature, with emphasis on the work *Sistema Naturae* by Carolus Linnaeus, considered a landmark of modern taxonomy, due to its ability to categorize the immense amount of information about living beings accumulated until then.

The professionalization of zoology intensifies in Europe in the mid-nineteenth century, together with the concept of life evolution, in Darwin's and Wallace's works, gathering several areas of investigation, such as anatomy, morphology, geology, physiology, histology, embryology, and the behavior. The Theory of Evolution transformed the classification of organisms, including a sense of unity of life, linked to complex relationships of kinship and ancestry, an epistemological and ontological rupture about the history of life on Earth.

With regard to science and biology teaching, the study on animals has always been present in Brazilian curricula and classrooms, at all levels of Elementary Education, covering aspects of the natural history of species, public health, evolution, and animal ecology, even if an essentialist thought of taxonomy has always prevailed in teaching, organized by the fragmentation and progressive ordering of biodiversity knowledge (Sanvik, 2007; Amorim, 2008). The most recent Brazilian normative curriculum document, the National Common Curricular Base, reduced the animal topic to a few text fragments, focused on characterization and organization skills, especially in the early years of Elementary Education, even though it points out that learning diversity, processes of evolution and maintenance of life – implicitly animal –, among others, enables students to “[...] understand, interpret and intervene in the world in which they live” (Brasil, 2018, p. 235).

This evident removal serve as an important warning to the effective establishment of a basic education committed to the socio-environmental and ethical responsibilities that the human species should and can exercise in the biological diversity conservation and preservation – in its completeness. Even more if we take into account that less than half of the biodiversity was cataloged, and that our knowledge of it is still very scarce (Primack, 2012<sup>2</sup> apud Oliveira, 2022). The school is a fundamental environment for the formation of character and values necessary for the biodiversity preservation (Bessa et al., 2018), as well as non-formal education and protected areas, especially if the objective is to break with the fragmentation and objectification of life, structures of the civilizational crisis that humankind is currently experiencing, which make it very difficult to materialize an environmental knowl-

edge articulated with processes of different orders of materiality and rationality (Leff, 2001). Processes that, in the educational field, require integrated actions that consider, in addition to taxonomic-evolutionary knowledge, cultural values, aesthetic fruition and the habit of visiting museums, appropriation of traditional and scientific knowledge, and the productive organization itself.

From the cultural point of view, Da-Silva and Coelho (2016) argue that the presence of zoological elements in the different manifestations of culture brings spontaneous debates to the classroom, enabling transitions between fiction and reality, in addition to stimulating reading, critical sense and creativity beyond the school context. Soler and Landim (2017), when discussing the animal role in exhibition narratives in three natural history museums, noted that the peculiarities of the animal as a museum object, such as the polysemy in cultural practices and human representations, are rarely explored, evidencing an animal silence as *musealia*, given the fluency of written language in the communication of scientific concepts.

In line with this scenario there are Goals 1, 17 and 19 of the Aichi Biodiversity Targets (UNEP, 2010), which aim at a society that proposes to participate in discussions and decisions regarding biodiversity and socio-environmental sustainability, and problematization and dialogue about biodiversity between scientific and cultural knowledge are necessary. This diversity includes the different representations of fauna, expressed in legends, fables, games, comics, as well as the debate on anthropomorphism, which imposes characteristics of evil or goodness on some species of animals, such as those highlighted in Jiménez (1998).

Another relevant aspect to think about teaching zoology is the study of representations of animal biodiversity in the media, considering that little is explored about values related to cultural diversity and environmental ethics, and the discourse focuses more on beauty and environmental services, with little emphasis on the traditional communities' knowledge (Roberto; Campos; Silva, 2016). Working with media – from the point of view of media and information literacy – should operationalize multiple perspectives on the objects of study, building the foundation for the development of democratic and critical thinking about what is conveyed in social networks and mass media. The importance of these discussions in preservice teacher education is stressed, particularly in science and biology teaching.

## **Material Production in Preservice Teacher Education**

In the composition of school life, the sequences of classes<sup>3</sup> are emphasized due to their potential for diversifying activities and forms of teacher-student, student-student, student-material interaction (Giordan, 2008). Pedagogue and writer Antoni Zabala discusses knowledge of how learning is produced in teaching-learning sequences (TLS) based on two points: the potential for favoring a greater degree of significance in learning and their ability to encourage teachers to pay attention to di-

versity (Zabala, 1998). The production of TLS has also been shown to be significant in the field of research on teaching training and practices, making it possible to discuss content, epistemology, students' conceptions and motivations, learning, pedagogical theories, and educational restrictions (Méheut; Psillos, 2004).

Silva, Prata and Christoffersen (2021) carried out a bibliometric analysis of publications on zoology teaching in Elementary Education in Brazil and found that the elaboration of didactic material is one of the main thematic focuses of the publications. Such authors point out that publications are concerned with making teaching processes more dynamic, based on innovative methods, including TLS, but also emphasize the relevance of non-formal education spaces, valuing their historical roots, political dimensions, and practical aspects, as a way to help the teaching-learning process.

With the objective of collaborating in the field of didactic planning and bringing elements to expand knowledge and approaches to new forms of understanding, narrating and, therefore, constituting the natural world with regard to fauna, we present this study on didactic sequences produced in the preservice science and biology teacher education. It starts from a less technical perspective on teacher training, which understands the teaching and learning processes as mental actions inevitably situated in cultural, historical, and institutional contexts (Mortimer; Scott, 2003), whose means of mediation are not, solely, the product of natural or necessary factors, but also of concrete sociocultural forces (Wertsch, 1991). To this end, one sought to answer the following research questions: which are the epistemic-pedagogical aspects that bring together zoology, environment, and society present in a set of didactic sequences? How does didactic planning in preservice teacher education enhance the means and mediation of knowledge of the animal life complexity?

## Research Context

The analyzed TLS were elaborated during five editions of subject of an undergraduate course at a public university in the state of São Paulo, whose focus was zoology teaching. The subject had as basic premises the students' active participation in activities, proposed from the social learning perspective (Jacobi, 2013), valuing the *dialogue* and local actors' joint *intervention* in reality; the development of *dynamic processes of participation and collaboration in new forms of thinking and facing problems* related to socio-environmental sustainability; the formation of *critical and creative thinking, in tune* with the need to propose answers for the future, and the analysis of the *complex relationships between natural and social processes* and of *acting* in the environment in a global perspective, *respecting sociocultural diversities*.

The script to produce TLS contained, among others, the following sections: title, target audience, context, objectives, materials, activity, and evaluation. The elaboration of a didactic object was mandatory,

and the undergraduates were responsible for creating objects such as applications, case studies, dioramas, games, models, simulations, and so on. The sequences and their respective didactic objects were analyzed in confluence with the organizational elements and properties of the Topological Model of Teaching (TMT) (Giordan, 2008), a theoretical-methodological tool derived from the Theory of Mediated Action, which integrates agents, cultural tools and thematization to plan educational practices that expand the learners' spheres of action and communication. The development of critical intellectuality in preservice teacher education (Giroux, 1997) is also methodologically grounded, contributing to the formation of transformational professionals who combine reflection and academic practices with the aim of educating students to become reflective and active citizens. Discussing the sequences from this perspective aims to focus on the ways of integrating knowledge of zoology, environment and society, expanding teacher activity spheres in zoology teaching, directed at teaching and learning processes.

## Research Data

During the five editions of the aforementioned subject, which took place between 2013 and 2018, 44 TLS were elaborated by 185 undergraduates<sup>4</sup>. The texts of the TLS were coded in relation to the planned concepts, and 31 key concepts were found (de Moura Silva, 2020). From the possible relationships between these concepts, the TLS were categorized into conceptual dimensions, and this article presents the activities falling into the *socio-environmental* (present in 75% TLS)<sup>5</sup> and *health* (present in 27% TLS) dimensions, whose focuses are interactions between animal life and the environment; the multiple perceptions and several types of traditional and cultural knowledge of the fauna; human beings' role in animal preservation and conservation, and the transmission, prophylaxis, and cure of zoonotic diseases.

Students attending the last two years of the subject carried out analytical-discursive activities related to the possibilities and limitations of the didactic objects produced in previous years, bringing their perceptions of the proposals focusing on rules, visual and conceptual contents, and positive and negative points. The didactic objects analyzed and problematized here were selected because they address, among other themes, anthropic impacts, anthropomorphization, traditional knowledge, and species conservation. These classes were recorded and put down in writing as event maps, inspired by microgenetic analysis, noting the details and interactions, which resulted in a meticulous event report (Goés, 2000). The statements are foundations for deepening the activities proposed in the TLS, expanding the scope of analysis of the didactic planning research<sup>6</sup>.

## Methodology

This is a qualitative research, which discusses the construction and organization of thought in zoology teaching in TLS, with critical

analysis of the contexts and meanings they bring, seeking to bring intellectual freedom to educational actions by releasing them from the shackles of technical rationality. In this quest, there is agreement on knowledge being influenced by social and historically constituted power relations, recognizing their axiological and ideological aspects. It is also understood that the concept-object / signifier-signified relationship is not stable, and that language plays a fundamental role in the formation of subjectivity (Esteban, 2010).

To characterize the TLS, contributions from *content analysis* were employed, considering that the TLS contemplate a universe of analysis that meets the rules of completeness, representativeness, homogeneity, and pertinence (Bardin, 2007). The TLS were numbered to refer to the year of their production and chapter number in the published e-books; [SD 2013\_01], for example, was produced in 2013 and corresponds to first teaching-learning sequence in the e-book *Possibilidades Didáticas para o Ensino de Zoologia* [Didactic possibilities for zoology teaching, Volume I]<sup>7</sup>. NVivo software (version 12.5.0) was used for data categorization, and then it was possible, among other operations, to organize, analyze, and triangulate information from different sources. There was categorization of aspects existing in the relationships that teaching and learning subjects can establish with the epistemic and pedagogical dimensions of knowledge, such as the proposition of didactic approaches, projection of educational concepts and practices, aspects of scientific literacy, domains of knowledge – didactic, epistemological and psychological –, use of representations and modeling, among other fundamental elements in the elaboration of didactic plans, generating a database with more than 12,500 coded references. The software made it possible posterior selection and grouping of correlated analysis units, such as words and/or text excerpts that are intended either to discuss a conceptual dimension, a theme, or to propose ways of teaching and/or ways of interaction with certain knowledge.

The analysis considered the structuring of the TMT that, giving voice to the sociocultural perspective and mediated action, highlights four properties as constraints: context and continuity; narrative and historicity; materiality, and mediation (Giordan, 2008). Expanding the scope of signified and meaning, one interpreted how the activities proposed were associated with the TLS construction elements, explained by Zabala (1998) as follows: search for prior knowledge; significance and functionality of new content; adequacy to the students' development levels; challenges inherent in zones of proximal development; cognitive conflicts and mental activity; favorable and motivating attitudes; self-esteem and self-concept, and autonomy, described by the author as learning to learn.

With regard to the analytical-discursive activities, the organizational procedures systematized by Giordan (2008, p. 64) were taken as reference for the selection of events and processes to be analyzed, in allusion to the ideological nature of the verbal interactions discussed by Bakhtin: verification of concrete conditions in which the interactions

took place – situationality and path followed by interactions –; examination of enunciative forms – value, functionality, and form –, and linguistic analysis – language grammatical and phonetic composition. As a complement to thematic understanding of discourse, the techniques proposed by Jay Lemke were also considered, by which some of the most essential semantic relationships were implicitly communicated in thematic patterns: equivalence and contrast; repetition with variation; structural strategies, and metadiscourses (Lemke, 1990).

The study of discursive interactions is a very fertile research field for understanding scientific language, and vice versa. Martins (2006) explains that the results of investigations under this perspective of analysis go beyond descriptions of the nature of the subjects' ideas content and begin to discuss the processes by which these ideas are proposed, negotiated, defended, and questioned in discourse. The author adds that interactions should be understood on a global and local scale, based on historical-social contexts and cultural tools available to the community, such as language and other symbolic systems of representation (Martins, 2006).

## **Results and discussion**

This article presents six TLS whose core activities converge to the development of knowledge that integrates aspects of zoology, environment, and society. Then, articulating knowledge and didactic-pedagogical approaches, the main proposals, possibilities and limits are analyzed based on the following themes: anthropomorphization; traditional knowledge; aesthetics and animal resources, and zoos, collecting and animal ethics.

### *Anthropomorphization*

The praxis of *health education* appeared in the apogee of the technical-utilitarian model, a way of teaching based on the application of knowledge and which seeks to formalize norms and standards, as well as dictating ways of acting and thinking about health utilities. According to Lopes and Tocantins (2012), this model has its origins in the biologism paradigm of explaining illnesses, a prodigal model of the twentieth century and the growth of capitalism, urban communities, and scientific development. If, on the one hand, the biologism paradigm unveils questions about disease contagion and transmission and focuses its actions on the relationships between etiological agents/human beings, on the other hand, that paradigm “[...] resulted in a reduced and insufficient understanding of the totality and complexity of the health-disease phenomenon, since it does not recognize social, cultural and ecological factors” (Lopes; Tocantins, 2012, p. 236). It is possible that the influence of this model on the way of thinking about health in teaching – possibly on how most of these undergraduates were educated in Elementary School –, become an obstacle to the materialization of transformational educational practices in the area.

Certainly, health is an area of great interest in the preservice science teacher education and that has intricate relationships with zoological education. Since the beginning of the twentieth century, medical zoology has a prominent place and is of national interest with regard to the understanding of issues related to public health, mainly in the field of sanitation as a tool for development policies, as well as investments in studies of tropical diseases, allied to the quality scientific research (Klassa; Santos, 2012). With regard to teaching, it is inserted in natural sciences curricula and textbooks, and its branches reach other areas of knowledge. In Elementary Education, for example, the BNCC (Brasil, 2018) maintains that health is a theme capable of integrating the three thematic units of the natural sciences area – matter and energy; life and evolution; Earth and universe – and criticizes the utilitarian health teaching when it relates the production of medicines and the body functioning, subjects that are very present in Basic Education.

To dialogue with the transitions between scientific knowledge and the sociocultural perspective, the basis will be the only TLS that planned an articulation between the *socioenvironmental* and *health* dimensions from an emancipatory point of view. This TLS is centered on a role-playing game (RPG) called *Hospedeiros e Helminthos* [Hosts and Helminths] [SD 2015\_11]. The game, like others in its category, places the main character, the worm, in the foreground, anthropomorphizing its actions as players. The worm player's goal is to complete its life cycle, and for that, it has to find a vector, enter an organism, survive in that environment, and reproduce. Through immersion in the game setting, which includes elements of collaboration between players, learners are expected to learn about life cycles, forms of contamination, prevention, prophylaxes, and cure.

In *Hospedeiros e Helminthos*, the worm characters are fictional, but have skills inspired by real animal characteristics. For example, “thieves” organisms have suction cups and are hermaphrodites, characteristics inspired by cestodes (Brusca; Moore; Shuster, 2018). Throughout the game, the worm players are faced with obstacles (events), which have to be overcome through resistance tests, whose result is defined by means of a dice roll. The randomness of these tests brings the game closer to the natural selection processes, inherent to natural systems. Nevertheless, the sense of volition is something very present and important for the proposal flow. The following excerpt, extracted from the initial game contextualization, highlights this feature:

They are tiny yet devastating beings that stalk the human world. Desperate to feed, reproduce and evolve. In search of a perfect home, a kingdom they can call their own, where they reach the supremacy always sought by members of their species [excerpt from SD 2015\_11].

Despite the non-biological use of the term “evolve”, the struggle for survival and the parasite villainization create a propitious scenario for a classroom debate about the existing tensions between natural systems and anthropocentrism. In this activity, for example, stimulating in the learners continuous processes between the playful imaginary and



the concrete reality would be a purpose of teaching mediation. Proposing games and case studies to turn a concept into ludic can be an important way to demystify subjects considered complex, such as basic sanitation and public policies. These material resources open up numerous possibilities for approaching the classroom, and they are not restricted to a specific practice, closed to opinions and dependent on content, and even allow teachers to learn about the cause.

With regard to material production in preservice teacher education, it was observed that the didactic object *Hospedeiros e Helmintos* can overcome the empiricist epistemology of teaching and learning, as it approaches the interactionist epistemology and sociocultural perspective (Moraes, 2013). Interactionist because it requires the learner to have an active participation regarding the material in view of the delineation of characters, immersion in events, and drama. Sociocultural for creating discursive spaces, where learners can appropriate the scientific language about parasitism, highlighting phenomena, creating hypotheses to deal with those phenomena, and making decisions.

Another relevant topic that can also be addressed from anthropomorphization is the animal species conservation. The TLS *O fantástico mundo do cerrado brasileiro* [The fantastic world of the Brazilian *cerrado*] [SD 2015\_07] proposes as a didactic object a series of four textbooks based on the *choose-your-own-story* model,<sup>8</sup> which tell the stories of four charismatic animals from the Brazilian *cerrado*: maned wolf, jaguar, *pampas* deer and burrowing owl, which differentiates them from most textbooks and games that focus their narratives on African animals.

The scripts take place in the *cerrado* biome and the characters' movements mobilize knowledge of adaptations and behaviors of these species, as well as the ecological interactions established in the biome. To continue the story, it is almost inevitable to attribute human feelings to animals, as the plots are full of melodramatic elements that provoke feelings of anguish and pleasure in readers, generating doubt and reflection in decision-making (Figure 1). This was evident in the statement of the undergraduates who analyzed the didactic object in 2016 (Chart 1).


**Figure 1 – Four pages from the book *O fantástico mundo do cerrado brasileiro* showing an excerpt from the story about the jaguar**

3

Você decide partir para cima dos veados-campeiros. Foi uma boa escolha. Eles correm rápido e isso te deixa cansada. Mas você é mais veloz, todas as onças-pintadas correm muito.

Você ataca um veado-campeiro da forma clássica: abocanha diretamente o crânio da vítima e mata o animal na hora. O resto do bando conseguiu fugir, mas você conseguiu uma presa grande... Isso deve ser suficiente para os próximos dias.

Vá para página 4



[http://2.bp.blogspot.com/-8004BHQ2A/YR8K6CMs6/AAAAAAAAA2Qg/1U7Z26H4Uk12600/0rNCFNA7s\\_pintada\\_.jpg](http://2.bp.blogspot.com/-8004BHQ2A/YR8K6CMs6/AAAAAAAAA2Qg/1U7Z26H4Uk12600/0rNCFNA7s_pintada_.jpg)

4

Depois de alguns dias você começa a sentir umas dores... São dores do parto. Você está prestes a dar à luz 3 filhotes. Está muito contente, esses 100 dias passaram rápido demais.

Finalmente todos nascem e passam bem. São duas fêmeas e um macho. Os bebês de onça-pintada nascem cegos e só começam a enxergar 15 dias depois, por isso, nesse momento são completamente dependentes de você! Serão 3 meses difíceis! Você terá que caçar para alimentar seus filhotes também.


Você não se sente segura de deixar seus filhotes sozinhos na toca enquanto sai para procurar comida. Sabe que outros animais podem atacá-los. Mas está com fome e eles também, você precisa caçar... O que você faz?

Não pode deixar os filhotes na toca, decide ficar com eles. Você pode aguentar a fome e amamentá-los por mais uns dias

Vá para página 5

Você é uma grande caçadora, capaz de predar em instantes. Eles vão ficar pouco tempo sozinhos, logo você volta com comida

Vá para página 6



<http://greenstyle.com.br/wp-content/uploads/2012/03/onco-pintada.jpg>

9

Como uma boa onça sempre faz, você preparou a emboscada e atacou num momento de distração da coruja. O bote teria sido perfeito. No entanto, a coruja percebeu e voou...


Infelizmente, não tinha nada que você pudesse fazer. Seus filhotes estavam sozinhos e você ainda estava com fome. Você já ficou muito tempo fora da toca, mas vê um pouco a frente outro bando de cachorros-vinagre. O que é melhor fazer?

Voltar para a toca, amamentar e proteger seus filhotes

Vá para página 11

Ir atrás do bando de cachorros-vinagre, afinal, você precisa se alimentar para poder cuidar dos seus filhotes

Vá para página 10



[http://www.foto.com.br/000/cachorro\\_vinagre\\_.jpg](http://www.foto.com.br/000/cachorro_vinagre_.jpg)

10

Você então retorna à toca com o cachorro-vinagre. Seus filhotes ficaram orgulhosos de você. Seria a primeira vez que iriam comer comida de verdade, além do leite. Eles estão crescendo... Daqui a pouco, já vão sair com você para caçar e aprender a se virar sozinhos...

Quando você chega, não encontra um de seus filhotes. Você não quer acreditar!! O que aconteceu aqui???? É então que você percebe uma cobra rastejando, era uma jiboia... Enorme! Essas cobras matam por constrição, são predadoras muito eficientes.


Você fica desesperada, não deveria tê-los deixado sozinhos... O que fazer?

Atacar a jiboia, ela pode querer dar o bote em você ou nos outros dois filhotes

Vá para página 11

Você e seus filhotes abandonam aquele território, evitando outro ataque da cobra

Vá para página 12



<http://www.herpetofauna.com.br/Serpentes-De-Usa-BonaticioFazer5.jpg>

Note: Text Translation for Figure 1: Page 3

You decide to attack the pampas deer. It was a good choice. They run fast and it makes you tired. But you are faster, all jaguars are fast runners. Your attack on the pampas deer is classic: you go straight for the victim's skull, kill it on the spot. The rest of the pack managed to escape, but you got a big prey... That should be enough for the next few days.

to Go to page 4

Page 4

After a few days you start to feel some pain... They are labor pains. You are about to give birth to 3 cubs. You are very happy, those 100 days went by too fast.

Finally, all of them are born and doing well. They are two females and one male. Jaguar cubs are born blind and only begin to see after 15 days, so now they are completely dependent on you! It is going to be 3 tough months! You will have to hunt to feed your cubs as well.

You don't feel safe leaving your cubs alone in the burrow while you go out to look for food. You know that other animals can attack them. But you are hungry and so are they, you need to hunt... What do you do?

1) You can't leave the cubs in the burrow; you decide to stay with them. You can endure hunger and breastfeed them for a few more days.

à Go to page 5

2) You are a great hunter, quickly able to find prey. They will spend some time alone, but you will soon come back with food.

à Go to page 6

Page 9

As a good jaguar always does, you set up the ambush and pounced at the first sight of the owl's distraction. The pounce would have been perfect. But the owl noticed and flew away...

Unfortunately, there was nothing you could do. Your cubs were alone, and you are still hungry. You have been out of the den for a long time, but you see another pack of bush dogs a little ahead. What is the best thing to do?

1) Go back to the burrow, nurse and protect your cubs.

à Go to page 11

2) Go after the pack of bush dogs, after all, you need to feed yourself to be able to take care of your cubs.

à Go to page 10

Page 10

You then return to the burrow with the bush dog. Your cubs will be proud of you. It will be their first time eating real food other than milk. They are growing... In a little while, they will go out hunting with you and they will learn how to fend for themselves...

When you arrive, you don't find one of your cubs. You don't want to believe it!! What happened???? That is when you see a snake crawling, it is a *Boa constrictor*... Huge! These snakes kill by constriction, they are very efficient predators.

You become desperate; you should not have left them alone... What to do?

1) Attack the boa constrictor, it may want to strike you or the other two cubs

à Go to page 11

2) Abandon that territory with your cubs, avoiding another snake attack

à Go to page 12

Source: Baruchi, Coelho, Maia, Murúa and Contro (2016).

### Chart 1 – Statements on the topic ‘anthropomorphization’ of the analytical-discursive activity (2016)<sup>9</sup>

Conversation circle – 2016	
JOANA:	[...] well, I think that...one of the strengths... of this activity is that it... makes the student... put himself in...someone else's shoes...because the... the wrong things you do ... often they are not so obvious [...] for example, a jaguar is ah... you lost a cub, you... ended up... in a zoo [...]
HELENA:	Well, that this story [sic] the child has to think like a predator, it's going to eat, I don't know, the cute little animal, it's just like, we're the jaguar, we think, "Wow, it really has to hunt to feed the baby jaguar?" [metadiscourse], then... a snake appears and [the jaguar] said "wow, do I run away, do I let the snake eat the baby? Or do I have to fight against it to save all the babies?" [metadiscourse] [...]
JOANA:	So, in this... this part is interesting because..... it doesn't show the predator, for example, as ah... as a bad thing [...] you know, as an evil thing,... it also shows its [animal] point of view, it also needs to feed, it needs to survive, so...

Source: Elaborated by authors – *Planejamento didático na formação de professores de Ciências e Biologia: perspectivas e referenciais para o ensino de Zoologia* [Didactic planning in the preservice science and biology teacher education: perspectives and references for Zoology teaching] Project.

The existing anthropomorphism in Joana's and Helena's statements – “put himself in someone else's shoes,” “you have to think like a predator,” “its point of view” – are indicative of the volition, decision making, expected from the readers of these books. It is noted that, in the midst of the idea of predation, the didactic object materializes some questions that can generate conflicting feelings in the reader-learner, related to the familiar sense of group, the attempt to escape, being proud of the successful hunting, and so on. In this sense, anthropomorphic and ecological elements stand out as possible influences on decision-making. The narrative of the TLS and books assumes that, apparently, this decision-making could stimulate young learners to appropriate ecological concepts, interactions between species, such as competition and predation. Furthermore, the narrative overcomes the classic Manichaeic structure of fables, which, according to Jimenez (1998), is based on the personification of evil predatory animals and good prey.

In the text prepared to guide the mediation of this textbook knowledge, the ecological aspects of the narratives are emphasized and, even though they place the reader-learners' “intuition” in their choices, they give little emphasis to it. Intuition is a very relevant aspect for the good development of this TLS, since it is in intuition that a large part of the stories composed by individualized reading are constituted, in which the anthropomorphic aspects will certainly have a great weight in decision-making. Helena's metadiscourses are evidence of this interpretation, when she refers to the cubs as “babies” and suggests sentimental conflicts with the predation process. Therefore, it is fundamental that the mediation of the knowledge expected in the TLS, human feelings, such as frustration and compassion, do not overlap the understanding of the organic aspects in the investigated phenomena, constituting true epistemological obstacles to the formation of the scientific spirit (Bachelard, 1996).

With the recognition of the cognitive conflicts inherent in the proposed readings, one considers that the didactic object makes it possible to enter realities that transcend sensitive experience and bring the reader closer to the habits of these animals, to survival and food matters. In allusion to the TMT (Giordan, 2008), the expansion of the learners' spheres of action and communication would occur insofar as there is stimulus to the clash between the cultural tools used in everyday life – in this case intuitive and volitional – and those used in scenarios built in the classroom – ecological knowledge.

### *Traditional Knowledge, Aesthetics and Animal Resources*

Working with traditional knowledge encourages attitudes of respect for traditional cultures, appreciation of popular knowledge, the socialization of diversified knowledge, the use of imagination to design conservation actions, and the investigative spirit to understand scientific thinking. A very intimate relationship with traditional knowledge materializes as legends in the TLS *O imaginário ambiental na tradição oral: contos e mitos sobre animais como ferramenta para o ensino de biologia* [Environmental imaginary in oral tradition: tales and myths about animals as a tool for biology teach-

ing] [SD 2015\_13]. The didactic object of this TLS, *Lendas e contos brasileiros com animais* [Brazilian legends and tales with animals] (Figure 2), appropriates the sociocultural perspective to bring together indigenous communities' traditional knowledge and scientific knowledge. Altogether, there are seven folkloric tales that deal with Brazilian animals, contextualized for the school environment. Learners are invited to explore and discuss the animal characteristics and their relationships with the environment, opposing and articulating scientific and popular knowledge.

Referred to by the team of authors as an undervalued didactic tool, oral storytelling would trigger a dialogic class on the importance of tales and legends and their differences from scientific literature. A teacher's instruction book comes together with the didactic object, with proposals for approaching these legends in the classroom. In the curassow legend, for example, the following questions are proposed: *For birds, what is the importance and functions of feathers? For birds, what is the importance of building nests?* The authors emphasize the scientific aspects related to the bird, such as habitat, threats and behavior, leaving the interpretation of the legend and popular knowledge to the readers-teachers, that is, concrete ways of mediating this clash are not presented, such as ways to work on the origin conflict of the curassow crest in the legend (spell) and the process of natural selection.

**Figure 2 – Page from the didactic object *Lendas e contos brasileiros com animais* tells the legend about witchdoctor Kanassa and the curassow**



Note: Text Translation for Figure 2.

A Kanassa *pajé* was walking through the woods when he met a curassow. This little animal was all busy, preparing a small ornament of feathers.

The *pajé* thought that interrupting one's work was a good way to show his sympathy and cordiality, and so he asked the curassow:  
What are you doing there?  
An ornament of feathers to ward off annoying Indians - said the curassow.  
Untroubled, the *pajé* sat down and waited for the curassow to finish his work.  
Let's see how it looks.  
The curassow looked at the *pajé* impatiently.  
Are you going to put it in your head? - asked the *pajé*.  
Yes, he said.  
So, put it on, what are you waiting for?  
The curassow then feared to be in the presence of a madman and decided to do what the Indian asked. After placing the huge feathers on the top of his head, he stood still, looking silly.  
Looks good - said the *pajé*.  
Appeased by this stroke to his ego, the curassow began to fly from here to there.  
Faster!  
The curassow flew in every direction, even upside down. At that point, the headdress detached itself and fell miserably.  
There it is! - said the Indian, slapping his thigh.  
Put it back on!  
The curassow put the feathers back on and the *pajé* took the opportunity to cast a spell on him. That is when the feathers took root in the head of the poor bird and never left.

Source: Melo, Martelini, Sato, Jorqueira and Cunha (2016).

To finish this TLS, the suggestion is the material production of other stories by the learners, reinforcing a concern with creativity and verbal expression, based on writing, use of symbology and other meanings. Protagonism is promoted in the creation of other stories and in the sharing of this knowledge created and recreated, including interdisciplinary aspects between science, Portuguese language, and arts.

In the conversation that took place in 2016, the book aesthetic aspects gave voice to the episode with the highest number of statements made that year. The buzz was present throughout this dialogue, many voices echoed together. The confluence of voices is an example of the aesthetic impact that the didactic object had on the circle participants. Some aspects of these statements bring important reflections for teaching planning.

At the beginning, two undergraduates expressed surprise in relation to the elaboration of the didactic objects, even questioning the authorship. Several aesthetic aspects were mentioned by the participants in this conversation circle. Expressions like "attractive", "well-made", "beautiful", "professional", "meticulous," and "poetic" highlighted the painstaking care regarding the material production. Surprise and enchantment with this didactic object are good descriptors of the undergraduates' statements. In addition to the fascination aroused by the analysis, Bruna's statement, highlighted in Chart 2 below, reveals how the focus on conceptual content is a paradigm that is difficult to break.

**Chart 2 – Excerpt from the episode with the highest number of statements in the analytical-discursive activity (2016)<sup>10</sup>**

Conversation circle – 2016	
SANDRA:	There's even, there's even stuff to keep it [sic], I thought it was well made.
BRUNA:	Ah, I wanted to talk about theirs [didactic object analyzed by the group], because... I thought it was cool I had never thought about it, when we were thinking about something cultural in our sequence, it was always related to... taxonomy, evolution... content... and I thought it was so beautiful!
LEANDRO:	Content... of... the university entrance exam.
HELENA:	I thought it really cool. Yeah... It goes there, that village of indigenous people who live in that place in Brazil, this legend here with the explanation about the emergence of the animals.
BRUNA:	It's even poetic!
CAMILA:	I think it was, you know, a subject... [cultural issues were matter of the course]
SANDRA:	It's just that we also thought about... more about... high school.
BRUNA:	Yeah, that's Grade 1, maybe 2 [of Elementary Education]. Yeah... they didn't say it, but we think it is. [...]

Source: Elaborated by authors – *Planejamento didático na formação de professores de Ciências e Biologia: perspectivas e referenciais para o ensino de Zoologia* [Didactic planning in the preservice science and biology teacher education: perspectives and references for Zoology teaching] Project.

Even later, when Sandra and Bruna speculate about the target audience of the object, it is notable how the hermetic, descriptive, and inert content assumes the leading role in thinking about material production. The so-called “content of university entrance exam”, as Leandro pondered. The proposition of contents in a sociocultural perspective allowed an open dialogue and a critical reflection in relation to the formal transmission of contents that prevails in university subjects and, unconsciously, shapes many undergraduates' thinking and creativity. Dialogical didactic strategies, which promote discussions of truly transforming teaching knowledge, are adequate to the challenges and needs that the undergraduates will have in their careers in terms of life in society and the school interdisciplinary potential. But for this to happen, activities have to be connected, bringing meaning to what is taught.

Talking about connection refers to the TLS *Caranguejo-uçá: da biologia dos crustáceos ao recurso socioambiental* [Swamp ghost crab: from crustacean biology to socio-environmental resource] [SD 2018\_06]. It starts with an online multiple-choice questionnaire with six questions, used to survey prior knowledge of this animal and its relationships with humans. The authors suggest that this questionnaire be promptly evaluated by the teacher – that is, soon after being filled up –, in order to explain to the learners what is known about the theme and what is projected to be achieved in the TLS development. The questions, in ad-

dition to raising knowledge of the indirect development of arthropods, address aspects of how ecological interactions, abiotic factors, and humans can impact the crab development. Bringing other elements of analysis from the environmental and economic spheres, the narrative leads to a final, investigative activity, mediated by another online tool, a website about the crab. On the website, they created a hypothetical scenario, but totally plausible, in which the swamp ghost crab populations in Bertioga channel, state of São Paulo, decrease drastically in 30 years, stimulating the learners to analyze the reasons.

In order to analyze what is happening and discuss responses to the problems that will be faced by the native population, the learners have to delve into crab biology, osmoregulation experiments, climatic conditions, collection regulation, and environmental characteristics of the place affected. With this, the authors' expectation is that learners will "[...] build a greater understanding of the socio-environmental relations associated with the swamp ghost crab economic exploitation" (Araujo; Arruda; Machado; Macedo; Vidal, 2019), taking a position on complex issues that contemplate perspectives of different social actors regarding the anthropic impact on crab populations.

The idea of giving ecological and sustainable bases to the production, in search of a balance between society and the environment, requires a process of deconstruction. There is a growing need to deal with diversity/heterogeneity and integrate values into knowledge without basing them on market laws in a blind manner. It is possible to see some of these ideas present in the planned activities of this TLS, marking some of the principles of the ecological and democratic culture of sustainable development discussed by Leff (2001, p. 131):

The rights of indigenous communities to self-manage their environmental resources to satisfy their needs and guide their social aspirations based on different cultural values, ecological contexts and economic conditions. [...] The value of biological diversity, cultural heterogeneity and political plurality, and also valuation of the peoples' natural and cultural resources heritage. [...] The perception of reality from a global, complex and interdependent perspective, which allows articulating the different processes that constitute it, understanding the multi-causality of socio-environmental changes and sustaining an integrated management of resources (our translation).

With regard to understanding the characteristics of endangered animals, one argues that case studies, such as this one, can be important allies for teachers, in the sense of promoting a critical position on the political actions that each individual can and should take in face of the scenario of environmental dismantling that humankind is experiencing. The swamp ghost crab TLS, referenced in this section, bets on the socio-environmental relations of human beings with ecosystem services and on the scientific knowledge of the endangered Brazilian fauna as a way of valuing biodiversity.



### *Zoos, Collections and Animal Ethics*

Zoos are very important institutions with regard to the animal socio-environmental study. Some propositions of activities present in the TLS with field trips to these environments were designed to initiate or complement knowledge of taxonomy and biodiversity. This knowledge is also indispensable for performing the TLS *Zoo + Ciência – Para além da exposição dos animais* [Zoo + Science – Beyond the animal exhibition] [SD 2015\_06], but something else stands out in this planning: the discussion about the social function of these spaces. In pursuit of this, the TLS suggests that interviews should be conducted with visitors during the field trip, investigating the public's impressions of the roles played by the visited institution. On returning to the classroom, the proposal is to analyze the interviews, and the TLS outcome takes place with the production of a poster for the spontaneous public, where problems raised from the interviews and solutions for improvements are presented.

The role of interviews as a didactic strategy is justified as a fundamental part of the construction of social knowledge. Knowing and substantiating the others' perspective in relation to social, environmental, and cultural issues is a lamentably uncommon way of social interaction in school activities. Likewise, it was important to observe the elaboration of structured activities to work with learners and the recognition of other zoo functions that are not just animal knowledge taxonomy, entertainment, leisure, and contemplation. According to the authors:

The biggest difference in the proposal lies in the *incorporation of the knowledge-producing dimension*, the production of zoo scientific content, and in the operationalization of methods that facilitate the scientific literacy of visiting students. Its function is also to reaffirm the importance of activities in zoos, botanical gardens, science museums, natural parks, etc.; based on its educational and literacy potential in sciences [Excerpt from SD 2015\_06, emphasis added]

It is also important to reflect on the ethical dilemmas of animal preservation in zoos, anticipating that this topic was proposed solely and exclusively in this TLS. Supplied with *in-loco* perception and post-analysis of interviews about the zoo, the TLS authors suggest that a debate be held for and/or against the existence of these environments. For this, they bring as pedagogical support four journalistic texts and the Brazilian Society of Zoology website. Taking "the debate" for granted, they move on to another activity, without making any notes on the mediation of knowledge. They do not clarify what the purposes of the activity are, but one supposes that they exist, such as fostering scientific argumentation, respecting opinions, and exploring consensus. These three purposes alone are already indicative that this debate will not take place without mediation, and it is expected that the statements and discursive interactions will be self-organized, even more having as argumentation foundations texts that present the facts in a dichotomous manner.

In the sphere of human relationships with other animals, another subject that comes close to ethical issues is biological collections. To discuss this topic, one analyzed the planning of the TLS *A importância das Coleções Biológicas* [The importance of biological collections] [SD 2015\_09], which aims to make learners understand the importance, functioning, and applicability of zoological collections, in addition to expanding understanding about the application of socioscientific knowledge to species conservation. The series of activities throughout the TLS takes place by means of questions such as the following: “Why does anyone collect anything? Do you believe there is any rule regarding animals and plants collection? In your opinion, what is the main objective of a museum?” The didactic objects of this TLS are a tutorial on making hypothetical animals with modeling clay, a dichotomous key, and a case study.

Working with hypothetical animals can be an alternative to approach aspects of taxonomy, according as a reduced number of available characteristics are used to proceed with the classification. This direction can be inconsistent from the natural point of view, but it can make the interpretation of inexperienced learners easier. In this case, the classification dichotomous key enables the learner to get in touch with the unique characteristics of individuals and groups.

After investigating animal taxonomy content, a visit to a museum that contains zoological collections is planned. The authors’ intention in this field trip is to bring learners closer to real collections and enable discussions about “[...] the ethical aspects related to collections” and how museums “represent biological diversity” (Rani; Vargas; Carrieri; Drequeceler; Fessardi; Garcia, 2019). In their research, Richter, Lenz, Hermel and Güllich (2017) highlighted that working with biological collections emphasizes the practical conception of teaching, as they arouse the learners’ interest and curiosity, and they are seen as more independent subjects, capable of establishing relationships between theory and practice. This understanding in relation to the activities of this TLS is ratified, but the emancipatory potential that this sequence can reach, from its ethical point of view, is also highlighted. In the case study on animal trafficking, which concludes the sequence, learners are mobilized to make decisions about the preservation of endemic areas, aimed at preventing the trafficking of (hypothetical) species supposedly threatened with extinction. This action should result in movements of otherness, insofar as it provokes clashes with the ethical dilemmas of taxonomic activity, mobilized by feelings of indignation at the behavior of the trafficker and empathy for endangered animals.

Fourez (1995) states that suffering is an encounter with otherness, a fundamental step for the construction of the ethical debate. He says that: “[...] ethics always starts from awareness of what we symbolically call evil, perceived at the outset as a situation that causes suffering, and about which something tells us, in ourselves and around us, is it necessary?” (Fourez, 1995, p. 247, our translation). In the aforementioned case study, the ethical debate could raise questions for learners such as:

Why could these “cute animals” not be pets? Wouldn't it be better if they were pets than placed in biological collections? Wouldn't this be a way of conserving the species, as zoos do? From another point of view, they could raise questions like: if there were no collection records of these trafficked animals, would it be possible to find out which region they are from? Without museums, what would we know about the physical characteristics of species? Is it possible to reduce the number of individuals collected per species? Would a few individuals give an idea about the population composition? It is evident that the ethical debate should be held by the teacher not only in the case study, but also in the relationships that are being built in the development of the TLS, but the way in which the sequence was developed opens mediation paths to explore these psychological and epistemological domains of knowledge.

There is a conflicting point about museological activity in schools, from a situational and historical point of view, which deserves to be discussed. According to Marandino, Selles and Ferreira (2009), school didactic collections were strengthened along with laboratory teaching in the mid-twentieth century. The authors emphasize the varied functions that objects, such as didactic collections, play in science teaching, in order to illustrate, demonstrate, explain, and even transform knowledge. Many schools, especially private ones, have laboratories with beautiful animal collections, including vertebrates.

Nevertheless, in Brazil, the creation and use of animals in educational teaching and research activities is restricted to higher education institutions and technical professional education in the biomedical area (Brasil, 2008). This law applies only to species classified as phylum Chordata, subphylum Vertebrata (Kardong, 2012). As far as one can see, this means that the scientific use of this taxon, whether in practical demonstrative or experimental classes, cannot be carried out in Elementary Education, unless in the appropriate technical institutions accredited by the National Council for the Control of Animal Experimentation (CONCEA). What about the other non-vertebrate animals, could construction and maintenance of insectariums be carried out, for example? The technical answer to this question, in principle, is no. The collection of zoological material must be authorized by the Chico Mendes Institute for Biodiversity Conservation (ICMBio), through the Biodiversity Authorization and Information System (ICMBio, 2014). This norm applies to higher education and there is no mention of collection activity in Elementary Education in this normative instruction. However, it is understood that it is not allowed, due to the obligation to obtain a license to collect any zoological materials. More reasons for valuing museums in educational activities.

Even with these regulations, experimental activity with animals, which was already much more present in science laboratories of Brazilian schools (Bones, 2012), still occurs. As well as the demonstrative use of school didactic collections in scientific practices, demonstrating a mismatch between regulatory laws and the school reality. As can be seen, this is an ethical debate in action, in which the voices of conse-

crated educational practices, recent legislation and of the role of didactic collections in science teaching should echo.

## Final Considerations

The analysis of TLS proved to be an important tool for teaching planning and reflection on the pedagogical practice carried out in the preservice teacher education, making it possible to think of and design new approaches to deepen socio-environmental aspects related to zoology teaching. One analyzed proposals that may have positive effects on the science/biology teaching-learning process, as they depart from conventional methods and approach the student reality, being able to encompass scientific knowledge from investigative didactic objects and interdisciplinary practices.

Didactic plans are important aspects of the construction of scientific biodiversity knowledge, whether as case studies, text readings or appropriation of non-formal teaching spaces, such as zoos, science museums and protected areas. Biodiversity is given meaning according as one embraces the complexity that comprises it, above all to measure the multiple relationships humankind establishes with it. Since Brazil is a megadiverse country, the emphasis on the biodiversity study has to be intensified (Almeida; Melo; Santos; d'Oliveira, 2022; Silva; Prata; Christoffersen, 2021), and such valuation begins at school. Considering the ethical impossibility of using animals in practical classes in Elementary Education, the research provides contributions to promotion of public policies in favor of zoology teaching and learning appropriate for the education level, but without disregarding the need to use teaching-learning active and collaborative methodologies and their production and discussion in the preservice teacher education.

Discussion was about issues of an anthropomorphic nature, and traditional knowledge can be valuable in understanding the animal characteristics and their ecological relationships, as well as in dialoguing with fauna representations by different cultures. Bearing in mind that no matter how synesthetic the literary events raised by the presented didactic objects are, it is necessary to consider the epistemic transits between subjective and objective knowledge, in order to value traditional knowledge and sustain the construction of scientific knowledge. Another highlight of these didactic objects is the striking aesthetic characteristic, a factor that fostered the development of reflective dialogues about the proposition of contents in the material construction of teaching thinking.

One affirms that it is necessary, at the level of preservice education and didactic planning, a greater depth on the political-economic aspects that regulate decision-making on biodiversity. It is necessary to address ways of structuring material production in preservice education, in order to add to didactic planning paths that also mobilize the learner's political participation in relation to this theme, subsidizing more critical postures of capitalist and consumerist economic rational-

ity. To further encourage the young learners' participation, preservice teachers should plan structured activities to generate themes related to the epistemological domain of endangered species, including controversial ones, such as human nutrition, epidemics and pandemics, climate change, changes in the land use, functional diversity of biodiversity, environmental legislation, rational use of ecosystem resources, among other subjects little discussed in the total amount of the teaching-learning sequences analyzed.

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- 2 PRIMACK, Richard. *A Primer of Conservation Biology*. Massachusetts: Sinauer Associates, 2012.
- 3 There are many terminologies to name sequences of classes, such as units, modules, activity sequence, learning sequence, among others, in addition to teaching-learning sequence (TLS), which was adopted in this article.
- 4 The research project was approved by the Ethics Committee of the Institute of Biosciences via *Plataforma Brasil* (CAAE 55607816.3.0000.5464).
- 5 The TLS were categorized into four conceptual dimensions: taxonomic, evolutionary, socio-environmental, and health-related. For more details, refer to de Moura Silva (2020).
- 6 To present the transcripts, the inspiration was the techniques presented by Neil Mercer, seeking to provide a minimum of technicalities in addition to accessibility to anyone interested in reading the document (Mercer, 1995).
- 7 The teaching-learning sequences and didactic objects produced can be consulted in the e-books *Possibilidades Didáticas para o Ensino de Zoologia na Educação Básica* [Didactic possibilities for zoology teaching in Elementary Education], volumes I to V (Silva; Del Corso, 2016; Silva; Barbosa, 2016; Silva; Silva, 2016; Silva; Silva, 2018; Silva; Silva, 2019).
- 8 In books of this type, in order to proceed with the story, the reader has to choose one of two (or more) proposed solutions to a problem presented. And so on, making decisions that have (good and bad) consequences for the characters in the plot.
- 9 Undergraduates dialogue about the didactic object *O fantástico mundo do cerrado brasileiro* (Baruchi, Coelho; Maia; Murúa; Contro, 2016). Names are fictitious.
- 10 Undergraduates dialogue about the didactic object *Lendas e contos brasileiros com animais*. Names are fictitious.

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