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INTERDISCIPLINARY POTENTIAL OF PARQUE NACIONAL SERRA DA BODOQUENA (PNSB): A PRACTICAL APPROACH FOR SCIENCE EDUCATION

POTENCIAL INTERDISCIPLINAR DO PARQUE NACIONAL SERRA DA BODOQUENA (PNSB): UMA ABORDAGEM PRÁTICA PARA O ENSINO DE CIÊNCIAS

POTENCIAL INTERDISCIPLINARIO DEL PARQUE NACIONAL SERRA DA BODOQUENA (PNSB): UN ENFOQUE PRÁCTICO PARA LA ENSEÑANZA DE LAS CIENCIAS

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Abstract: For a more meaningful education, students in the Biological Sciences program need practical experience in natural environments, so that the knowledge acquired in the classroom in Environmental Education and Interpretation can be applied and enhanced. The Serra da Bodoquena National Park (PNSB) perfectly fits this approach, as it is a protected area rich in biodiversity and scenic landscapes, where interpretive trails were conducted with the support of guides and professors from the Federal University of Grande Dourados. Students gained

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knowledge about protected area management, ecotourism, biodiversity, and environmental conservation. Considering the learning potential, this work aims to report the experiences of undergraduate and postgraduate students in Biological Sciences at PNSB, seeking to understand its educational potential, based on the premise of which Science Teaching content could be taught. Six content areas were selected for analysis: geology, botany, invertebrates, chordates, ecological relationships, and Environmental Education. As activities progressed and materials were collected along the trails, it was possible to understand the park's educational potential through these areas of study. Thus, participants were immersed in an environmental reality learned in their subjects, comparing and deepening their understanding of concepts.

Keywords: Biodiversity, Conservation, Environmental education, Interpretive trails.

Resumo: Para uma formação mais significativa, os estudantes do curso em Ciências Biológicas necessitam de práticas em ambientes naturais, para que os conhecimentos adquiridos em sala de aula em Educação e Interpretação Ambiental sejam trabalhados e aprimorados. O Parque Nacional da Serra da Bodoquena (PNSB) se enquadra perfeitamente como esse tipo de abordagem, por ser uma área protegida, rica em biodiversidade e paisagens cênicas, onde realizaram-se trilhas interpretativas com o apoio de guias e docentes da Universidade Federal da Grande Dourados, adquirindo conhecimentos sobre gestão de áreas protegidas, ecoturismo, diversidade de seres vivos e conservação ambiental. Levando em consideração o potencial de aprendizagem, este trabalho tem o objetivo de relatar as experiências dos graduandos e pós-graduados em Ciências Biológicas no PNSB, buscando compreender seu potencial educativo, partindo da premissa de quais conteúdos do Ensino de Ciências poderiam ser ensinados. Foram selecionados para análise 6 conteúdos: geologia, botânica, invertebrados, cordados, relações ecológicas e Educação Ambiental. Com o decorrer das atividades e os materiais registrados ao longo dos trajetos, foi possível compreender o potencial educativo do parque, por meio dessas áreas de estudo. Assim, inseriu-se os participantes em uma realidade ambiental apreendida em suas disciplinas, comparando e aprofundando conceitos.
Palavras-chave: Biodiversidade, Conservação, Educação Ambiental, Trilhas interpretativas.

Resumen: Para una formación más significativa, los estudiantes del curso de Ciencias Biológicas necesitan prácticas en entornos naturales, para que los conocimientos adquiridos en el aula en Educación e Interpretación Ambiental sean trabajados y mejorados. El Parque Nacional de la Serra da Bodoquena (PNSB) encaja perfectamente con este tipo de enfoque, ya que es un área protegida, rica en biodiversidad y paisajes escénicos, donde se realizaron senderos interpretativos con el apoyo de guías y docentes de la Universidad Federal de Grande Dourados, adquiriendo conocimientos sobre gestión de áreas protegidas, ecoturismo, diversidad de seres vivos y conservación ambiental. Considerando el potencial de aprendizaje, este trabajo tiene como objetivo relatar las experiencias de los estudiantes de grado y posgrado en Ciencias Biológicas en el PNSB, buscando comprender su potencial educativo, partiendo de la premisa de qué contenidos de la Enseñanza de las Ciencias podrían enseñarse. Se seleccionaron para el análisis 6 contenidos: geología, botánica, invertebrados, cordados, relaciones ecológicas y Educación Ambiental. Con el transcurso de las actividades y los materiales registrados a lo largo de los recorridos, fue posible comprender el potencial educativo del parque, a través de estas áreas de estudio. Así, los participantes se insertaron en una realidad ambiental aprendida en sus disciplinas, comparando y profundizando conceptos.

Palabras clave: Biodiversidad, Conservación, Educación ambiental, Senderos interpretativos.

INTRODUCTION

The Serra da Bodoquena National Park (PNSB), located in Mato Grosso do Sul, encompasses the municipalities of Bonito (33.2%), Bodoquena (27.5%), Jardim (7%), and Porto Murtinho (32.3%). Situated in an overlapping area of two Biosphere Reserves declared by UNESCO: the Pantanal and the Atlantic Forest, it is considered one of the last significant remnants of the Atlantic Forest in the Cerrado Biome region (BRAZIL, 2024).

These reserves are extensive areas that include representative collections of ecosystems, where alternatives for human development compatible with biodiversity conservation are sought. To fulfill their functions, they follow a territorial plan that includes core, buffer, and transition zones (CORRÊA, 1995).

As seen in the (PNSB) Management Plan, this set of environments is home to an exuberant fauna, with the presence of diverse mammals such as: deer, armadillos, peccaries, collared peccaries, macaws, otters, capuchin monkeys, tapirs, capybaras, pacas, tayras, crab-eating foxes, pampas cats, and bush dogs.

Approximately 400 species of birds have been recorded, two new species of fish have been identified, and rare species of reptiles and amphibians. Due to its unique relief, the park is notable for its stunning landscapes, including river channels with emerald and bluish waters, waterfalls, canyons, sinkholes, and resurgences.

Its main attractions include the Sumidouro-Ressurgência do Rio Perdido and Cânions do Rio Salobra trails, which are the focus of the activities carried out by the students (BRAZIL, 2024).

Trails: Interpretation and Environmental Education

The contact between human beings and nature in contemporary societies is predominantly capitalist, where human beings are increasingly perceived as the center of the world. It is also often hampered by cultural barriers, such as consumerism and the influence of the media, making this relationship less harmonious (SILVA & SAMMARCO, 2015; PROJETO DOCES MATAS, 2002). Given this, the practice of Environmental Education (EE) is fundamental to promote a more balanced and sustainable interaction between people and the environment.

EE has several definitions and according to Law No. 9.795, of April 27, 1999:

> "Environmental education is understood as the processes through which the individual and the community build social values, knowledge,

> skills, attitudes, and competencies aimed at the conservation of the environment, a good of common use of the people, essential to a healthy quality of life and its sustainability" (BRAZIL, 1999).

Reigota (2010) criticizes the view of environmental education limited only to the conservation of species and natural resources. As an alternative, he proposes Political Environmental Education (PEE), which broadens the concept of EE by integrating nature conservation with the political, economic, social, and cultural relationships between humanity and the environment, in addition to the relationships between human beings themselves.

PEE seeks to promote the freedom and autonomy of the democratic citizen, encouraging reflection on negative attitudes in the interactions between human beings and nature, and promoting positive attitudes that aim at a dignified coexistence and the common good in harmony with the environment (REIGOTA, 2010).

Among its activities is Environmental Interpretation (EI), which is defined as an activity carried out to improve the understanding of the natural environment in protected areas, which the "Serra do Bodoquena National Park" fits into, along with museums, nature interpretation centers, and other environments that can be used for EI (MOREIRA, p.78, 2014).

Jacobucci (2008) argued that non-formal spaces become a necessary means to achieve the objectives of PEE and environmental interpretation. They allow students to actively participate in the learning process, rather than being mere recipients of information. This approach is especially effective in developing critical and reflective skills, in addition to sensitizing students to environmental issues. Given this, ecological trails inserted in floristic green areas significantly impact the operationalization of pedagogical practices aimed at science teaching and environmental interpretation, bringing an interdisciplinary character (PIN & ROCHA, 2020).

The Serra da Bodoquena National Park (PNSB), being a Conservation Unit, has great importance for environmental conservation because Law No. 9.985, of July 18, 2000, defines CU as:

> "A territorial space and its environmental resources, including jurisdictional waters, with relevant natural characteristics, legally established by the Public Power, with conservation objectives and defined limits, under a special management regime, to which adequate protection guarantees apply" (BRAZIL, 2000)

These qualities make it a perfect candidate for field trips, as it is open to excursions, featuring hikes on two trails, where it is likely to observe a wide variety of flora and fauna, rock formations and water bodies, along with several natural phenomena that have already occurred in the park, and activities of EI can be considered in this region.

Given the above, taking into account the ecological and geological diversity of the explored locations, an expressive environment for learning in the field is perceived, in this way, this work aims to understand the educational potential of the Serra da Bodoquena National Park (PNSB) through a question, what are the contents of Science Teaching that can be addressed in this event?

In this sense, the objective of this work is to report the experiences of undergraduate and graduate students in Biological Sciences at the Serra da Bodoquena National Park (PNSB), investigating the educational potential for Science Teaching.

MATERIALS AND METHODS

The visit to the Serra da Bodoquena National Park (PNSB) took place between August 7th and 11th, 2024, during which, the 10th and 11th were destined for the exploration of two trails.

The first, the trails of the Sumidouro-Ressurgência do Rio Perdido, the second, in the Canyon of the Rio Salobra. In both cases, the students were accompanied by guides, as well as, by professors from the Federal University of Grande Dourados (UFGD), Dr. Jairo Campos Gaona and Dr. Diego Marques da Silva Medeiros.

To understand the educational and interpretive potential of the Serra da Bodoquena National Park (PNSB), the academics raised and cataloged everything they considered relevant in the activity.

The data analysis involves the identification of species of animals, fungi and plants, as well as the observation of geological formations and natural phenomena from the records made. In addition, the study includes the measurement of the distances traveled on the park's trails, with a focus on the Trails of the Sumidouro-Ressurgência do Rio Perdido and the Canyon of the Rio Salobra.

With the aim of covering a greater probability of themes within science teaching, 6 contents were selected, namely: 1- Geology and natural phenomena; 2- Botany; 3 - Invertebrates; 4 - Chordates; 5 - Ecological Relations, finally, 6 - Environmental Education, in order to understand how and if these themes could be applied.

It is important to reinforce two pieces of information: 1- That the Geotracker application was used on the routes, to determine the distance traveled in each activity; 2 - That before the activities, the undergraduate and postgraduate students participated in meetings in the previous months, to point out and discuss about the appropriate behaviors to be followed in the park.

RESULTAS AND DISCUSSION

As mentioned earlier, two trails were visited during the visit, the Sumidouro-Ressurgência do Rio Perdido Trail and the Rio Salobra Canyon Trail. With the help of the Geotracker application, the distances of the routes were traced. In this way, it was discovered that on the Sumidouro-Ressurgência do Rio Perdido Trails (Figure 1a) the participants walked 7.73 km of round trip, as well as on the Rio Salobra Canyon trail (Figure 1b), obtaining 6.23 km.

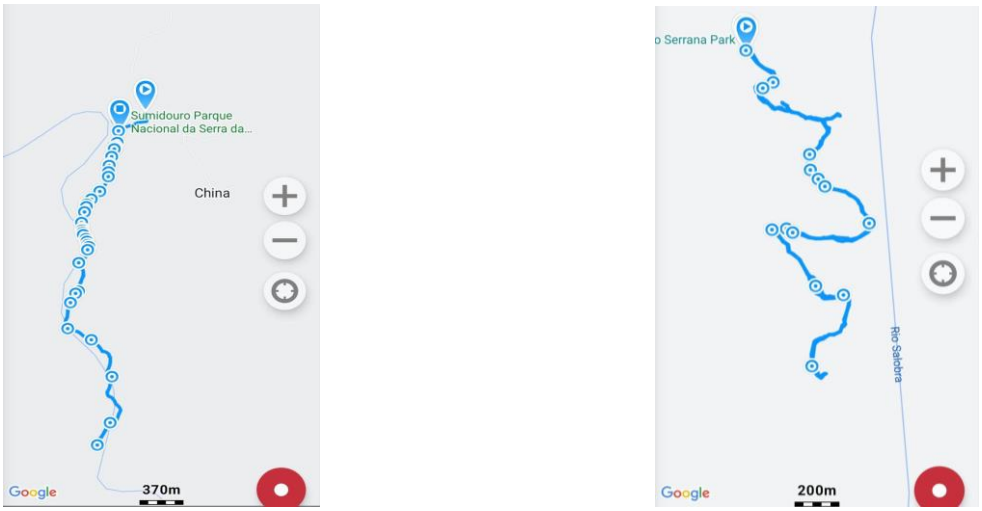

Figure 1. Trails of Sumidouro-Ressurgência do Rio Perdido (a) and Trail in the Canyon of the Rio Salobra (b).
Source: Geotracker/Own authorship, 2024.

It is worth noting that both trails are accompanied by visible bodies of water from the beginning to the end of the routes, however, the Rio Salobra Canyon trail stands out, as, as can be seen in (Figure 2a), being an "Aquatrekking", it presents stretches of the route in direct contact with the river, making the walks more difficult and challenging.

The Trails of the Sumidouro-Ressurgência do Rio Perdido, on the other hand, are characterized by having contact with the water sources at the beginning and end of the route. This is the condition that gives the trail its name -Sumidouro-Ressurgência-, in (Figure 2b) it is

possible to observe some decks along the way, where people can dive, rest and enjoy the landscape.

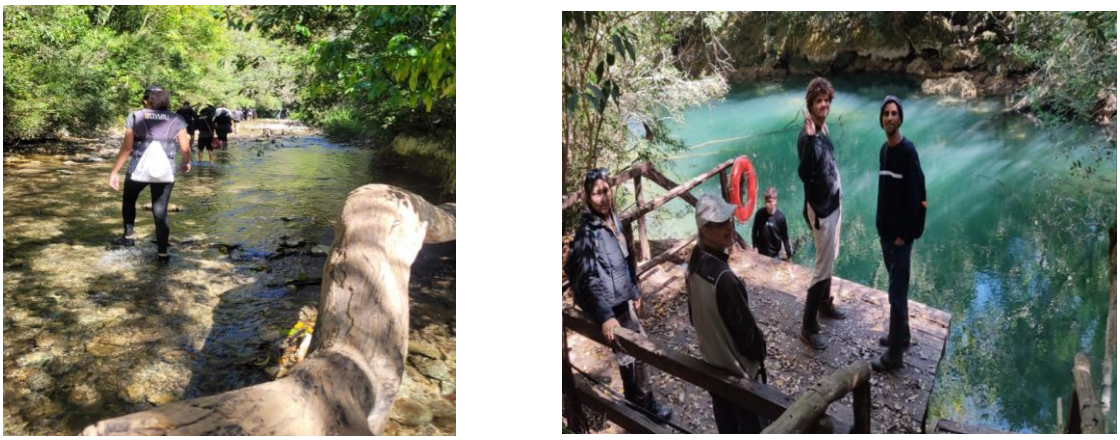

Figure 2. Canyon Trail of the Rio Salobra (a) and Trail of the Sumidouro-Ressurgência do Rio Perdido (b).
Source: Own authorship, 2024.

During the activities at the PNSB, the participants encountered circumstances to be analyzed, which could be animals, plants, fungi, geological elements, among others.

In this way, the records were divided into 6 areas of knowledge within Science Teaching, being them: 1- Geology and natural phenomena; 2- Botany; 3 - Invertebrates; 4 - Chordates; 5 - Ecological Relations and 6 - Environmental Education.

1. Geology and Natural Phenomena

During the trails, the constant presence of geological elements was notable on all the trails, such as the carbonate rocks (Figure 3), which were part of the routes and presented a variety of shapes and sizes, the result of weathering caused by the water currents.

Figure 3. Carbonate Rock on the Rio Salobra Canyon Trail.
Source: Own authorship, 2024.

This weathering process can alter the courses of rivers, creating cavities in the rocks, resulting in the formation of whirlpools (Figure 4), which in turn, represent that the flow of

water is not following the usual path and can, over time, create new paths or even form caves. These phenomena are important for understanding the local geology.

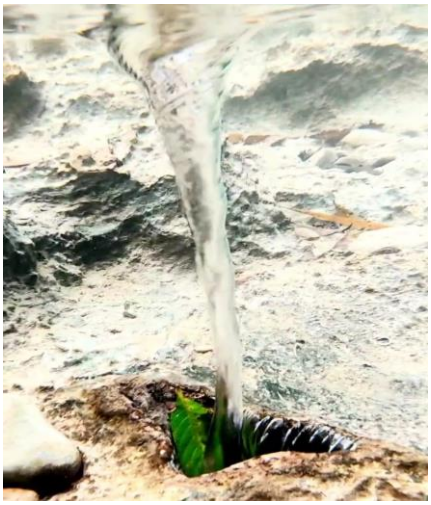

Figure 4. Whirlpool in the carbonate rocks on the Rio Salobra Canyon trail.
Source: Own authorship, 2024.

These analyzes delimit the importance of rocks and weathering processes in the formation of geological characteristics and in the modeling of the environment. This information provides a rich basis for educational activities, allowing students to explore and understand how geological processes shape the landscape and influence the natural environment.

2. Botany

Along the two trails, individuals from the main groups of plants were sighted, mostly bryophytes, pteridophytes and angiosperms, and in smaller quantities gymnosperms. This richness of different plant species allowed participants to reinforce and discuss the knowledge acquired in their graduations, such as, for example, the characteristics and differences of each group. Figure 5 below shows some specimens found on the trails.

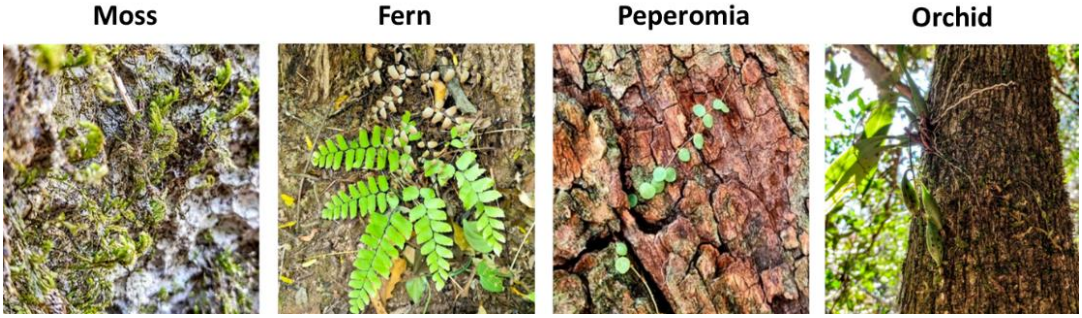

Figure 5. Main plant groups identified in the Serra da Bodoquena National Park.
Source: Own authorship, 2024.

According to the evolutionary order of the groups, in both trails, species of bryophytes were seen attached to arboreal and shrubby plants, as well as on rocks and decaying materials. As these are environments with abundant humidity, the state of conservation and appearance of this group is high.

Pteridophytes, on the other hand, were observed in greater quantity and diversity on the Rio Salobra trail. Among some specimens found, the highlights are the maidenhairs, ferns and selaginellas. As mentioned earlier, few specimens of gymnosperms were identified, only different types of araucarias.

Following the group with the most representatives found, the angiosperms, where they observed:

- Bromeliads of the *Tillandsia L*. group;
- Rupicolous plants on the walls of the Rio Salobra Canyon;
- Epiphytic succulents of the genus (*Peperomia*) Ruiz & Pav.
- Bacuri (*Attalea phalerata*) Mart. ex Spreng, used in several areas such as food and medicinal (NETO & MORAIS, 2003; LIMA *et al*. 2019; ACACIO, 2023).

3. Invertebrates

Regarding the presence of invertebrates in the park, some specimens of insect groups are recorded, such as beetles, butterflies (Lepidoptera) (Figure 6). An exoskeleton of a cicada (Hemiptera-Cicadidae) (Figure 7) was also found, which plays a fundamental role, serving as a bioindicator, in addition to indicating the change of stage in the cicada's development.

Figure 6. Butterfly (*Lepdoptera*) found in the Canyon of the Rio Salobra.
Source: Own authorship, 2024.

Figure 7. Cicada Exoskeleton on the Rio Salobra Canyon Trail.
Source: Own authorship, 2024.

Entering other groups of invertebrates, examples of the phylum Mollusca were photographed, a snail shell (Gastropoda) (Figure 8) and Waterfall Spiders (*Arachnida - Trechaleidae*) (Figure 9), both widely used in habitat conservation studies.

Figure 8. Waterfall Spiders (*Arachnida - Trechaleidae*) located in the Canyon of the Rio Salobra.
Source: Own authorship, 2024.

Figure 9. Snail shell (Gastropoda), photographed on the Trails of Sumidouro-Ressurgência do Rio Perdido.
Source: Own authorship, 2024.

4. Chordates

Among the chordates recorded, the highlights are: capybaras (*Hydrochoerus hydrochaeris*) (Figure 10), southern tamandua (*Tamandua tetradactyla*) (Figure 11), giant anteater (*Myrmecophaga tridactyla*), red-legged seriemas (*Cariama cristata*) (Figure 12), toucans (*Ramphastidae spp.*), red-and-green macaw (*Ara chloropterus*), blue-and-yellow macaw (*Ara ararauna*), hyacinth macaw (*Anodorhynchus hyacinthinus*), harpy eagle (*Harpia harpyja*), emu (*Dromaius novaehollandiae*) and the heron (*Ardeidae sp.*).

Figure 10. Capybara at the beginning of the trail of the Sumidouro-Ressurgência do Rio Perdido.
Source: Own authorship, 2024.

Figure 11. Southern tamandua on the way back from the trail of the Sumidouro-Ressurgência do Rio Perdido.
Source: Own authorship, 2024.

Figure 12. Seriemas spotted on the way back from the trail of the Sumidouro-Ressurgência do Rio Perdido.
Source: Own authorship, 2024.

5. Ecological Relations

Among the ecological relationships recorded, one of them was quite abundant, being the interaction between termites and trees, parasitism (Figure 13), where the termites feed on the cellulose of the wood, weakening and deteriorating the structure of the plant, eventually, being able to lead them to death, uniquely benefiting the termites, which are responsible for the degradation of wood (GRIMALDI & ENGEL, 2005; GULLAN & CRARSON, 2017).

Figure 13. Termite parasitism on trees on the Rio Salobra Canyon trail.
Source: Own authorship, 2024.

Another example of an ecological relationship identified in the PNSB was mutualism, expressed in the interactivity of fungi with algae and/or cyanobacteria, thus forming lichens

(Figure 14). The fungus provides protection and a suitable environment for the algae and cyanobacteria, which, in return, photosynthesize and provide nutrients for them, favoring the mutual survival of the species involved (NUSBAUMER *et al*, 2015).

Figure 14. Lichens on the trees of the trails.
Source: Own authorship, 2024.

Finally, epiphytism was also found, a harmonious interaction in distinct plants, where one individual uses the other as support for its development, but without harming it (ROMERO & CASTRO, 2024).

6. Environmental Education

Along the trail, the guides used scientific knowledge provided on identification plates (Figure 15) to help explain the route, the animals, and the plants present in the locations. This work is crucial, as it provides excursionists with detailed information regarding the peculiarities and potentialities of the environments, as well as helping to raise awareness about the importance of preservation and providing appropriate behavioral guidelines on the trails.

Figure 15. Guide providing information about the PNSB at the beginning of the Sumidouro Trail.
Source: Own authorship, 2024.

A point worth mentioning is that along the trails, the students came across informative signs all the time, instructing them about the correct directions to be followed, thus preventing people from leaving the trails and reaching nests and burrows of animals in the woods.

It is understood, then, that the region of the Serra da Bodoquena National Park (PNSB) presents a pertinent educational potential, which can be explored for the elaboration and application of field classes for students of the Biological Sciences course. The area harbors an expressive variety of living beings, allowing to work concepts of ecological relations, habitats, feeding and curiosities regarding the local biodiversity, offering the opportunity to learn in a non-formal space.

The practice of Environmental Education (PEE) in the PNSB is substantial, as it promotes awareness regarding the conservation of biodiversity and the development of a harmonious relationship between human beings and the environment, awakening in students, sensitivities for the protection of these places with the need for the development of sustainable practices, since they are threatened by social and political issues.

CONCLUSION

The Serra da Bodoquena National Park served as an ideal setting for an effective educational approach to promoting Science Teaching through practical field activities,

since, with the trails, diverse animals, plants, geological elements, natural phenomena and their interactions with each other were recorded, in this way, consolidating and reinforcing concepts learned in graduation and inserting them into a non-conventional teaching environment, as well as offering a practical and applied perspective, with notorious potential for effective learning.

The inclusion of aspects referring to Political Environmental Education and Environmental Interpretation provides a broad understanding of the role of education in the formation of critical and responsible awareness, from the connection of the knowledge acquired in the routes with the realities and challenges faced in the political and social spheres.

It is worth noting that there are some limitations, such as the need for meticulous planning and adaptation to the variable conditions of the environment. These challenges underline the importance of careful and flexible preparation to maximize the benefits of these practical activities within the Serra da Bodoquena National Park.

In summary, activities that put students in direct contact with environmental reality provide highly enriching sensory and cognitive experiences. The Serra da Bodoquena National Park, classified as a Full Protection Conservation Unit (UCPI), offers a natural environment where the use of resources is restricted to indirect purposes, such as scientific research and educational activities.

This restriction requires authorizations from the competent bodies, such as ICMBio, to ensure the preservation of ecosystems. In this way, the park serves as a model of conservation in the state of Mato Grosso do Sul, and an important example for Brazil, standing out for its commitment to protection and quality environmental education.

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