

From the Cave to the Classroom: A Place-Based Interdisciplinary Educational Proposal

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Abstract

This article presents a Phd research conducted between 2020 and 2024 in the speleological region of Alto do Ribeira, in the southwest of Brazil. The study involved four public schools located near conservation units with a high occurrence of caves. A speleological inventory was developed using a collaborative method to qualify caves for educational and geoconservation purposes. Based on the collected data, a teaching program was created using caves as a place-based generating theme. The work was aimed at basic education teachers and students, especially those in the 7th, 8th, and 9th grades. The program included educational materials and practical activities, linking the theme of caves to national curriculum guidelines. During the implementation, questionnaires were administered to evaluate the process. The results indicate that caves are a valuable resource for re-signifying curricular content, integrating different disciplines, and strengthening the connection between students, teachers, and the environment to which they belong.

Résumé

Cet article présente une recherche doctorale menée entre 2020 et 2024 dans la région spéléologique d'Alto do Ribeira, dans le sud-ouest du Brésil. L'étude a impliqué quatre écoles publiques situées à proximité d'unités de conservation avec une forte occurrence de grottes. Un inventaire spéléologique a été élaboré à l'aide d'une méthode collaborative afin de qualifier les grottes pour des usages éducatifs et de géoconservation. Sur la base des données collectées, un programme pédagogique a été conçu en utilisant les grottes comme thème générateur basé sur le lieu. Le travail était destiné aux enseignants et aux élèves de l'enseignement fondamental, en particulier ceux des 7^e, 8^e et 9^e années. Le programme comprenait des supports éducatifs et des activités pratiques, reliant le thème des grottes aux directives du programme national. Lors de la mise en œuvre, des questionnaires ont été administrés pour évaluer le processus. Les résultats indiquent que les grottes constituent une ressource précieuse pour redéfinir le contenu des programmes scolaires, intégrer différentes disciplines et renforcer la connexion entre les élèves, les enseignants et l'environnement auquel ils appartiennent.

Resumo

Este artigo apresenta uma pesquisa de doutorado realizada entre 2020 e 2024 na região espeleológica do Alto do Ribeira, no sudoeste do Brasil. O estudo envolveu quatro escolas públicas localizadas nas proximidades de unidades de conservação com uma alta ocorrência de cavernas. Um inventário espeleológico foi elaborado utilizando um método colaborativo para qualificar as cavernas para usos educativos e de geoconservação. Com base nos dados coletados, um programa pedagógico foi desenvolvido utilizando as cavernas como tema gerador baseado no lugar. O trabalho foi destinado aos professores e alunos do ensino fundamental, especialmente das 7^a, 8^a e 9^a séries. O programa incluía materiais educativos e atividades práticas, conectando o tema das cavernas às diretrizes do currículo nacional. Durante a implementação, questionários foram aplicados para avaliar o processo. Os resultados indicam que as cavernas constituem um recurso valioso para redefinir o conteúdo dos programas escolares, integrar diferentes disciplinas e fortalecer a conexão entre alunos, professores e o ambiente ao qual pertencem.

1. Introduction

Throughout history, the survival of civilizations has always depended on nature and its resources. However, climate change has intensified migration flows and impacted various regions, including Brazil (NATIONAL RESEARCH COUNCIL et al., 2010; STEWART e STRINGER, 2012; ARAUJO e PILÓ, 2003; 2017). During industrial expansion, an anthropocentric view of nature prevailed, but since the 1970s, ecological concerns and debates on sustainable development and environmental conservation have grown (BUENO, 2008; MCDONOUGH e BRAUNGART, 2010).

Despite theoretical advancements, the practical application of these concepts in education remains limited. The study presented is part of a doctoral project conducted at the Institute of Geosciences at

USP (2020-2024) and investigates the potential of caves as an interdisciplinary generating theme in basic education. The research aimed to strengthen the sense of place, knowledge appropriation, and territory valuation, contributing to more meaningful learning (Kakazian, 2005; Santangelo e Bramanti, 2006).

Despite challenges such as the pandemic and changes in São Paulo's educational policy, the study achieved its main objectives: (a) developing a mechanism for cave inventory and qualification for educational use and geoconservation, (b) implementing an interdisciplinary educational proposal in public schools, (c) creating place-based educational materials, and (d) evaluating the impacts on learning and the national curriculum.

1.1. Study Area

The Alto do Ribeira region was chosen for this research due to its rich speleological heritage, the need for local community involvement in geoconservation, and the opportunity to integrate caves as an interdisciplinary theme in elementary education. The region, located in southwest São Paulo, includes several conservation units such as PETAR, PECD, PEI, and CB, known for their high concentration of caves and biodiversity, hosting 22% of Brazil's remaining Atlantic Forest.

In addition to its ecological importance, the region is a hub for nature and cultural tourism, with speleotourism serving as a key economic

activity (Novaes, 2022; da Silva et al., 2021). Despite numerous scientific studies, geological heritage information remains largely confined to technical communities, and local schools lack programs that connect students with their environment (Ferreira et al., 2018; Santos, 2019). This gap is particularly concerning given the region's low Human Development Index (HDI) (Gonçalves e Souza, 2001).

Aligned with global sustainability initiatives, such as the 2030 Agenda and Brazil's National Speleological Conservation Program, the study highlights the need for geoconservation education strategies that promote environmental awareness, local heritage appreciation, and scientific engagement

2. Materials and methods

The realization of this research was organized into four main stages: (A) literature review, (B) outlining an educational proposal, (C) development of the educational proposal in schools, and (D) data collection and analysis of the results. At each stage, the main scientific outputs were

published in national and international journals related to the topic, articles that complement this paper and are referenced throughout the document.

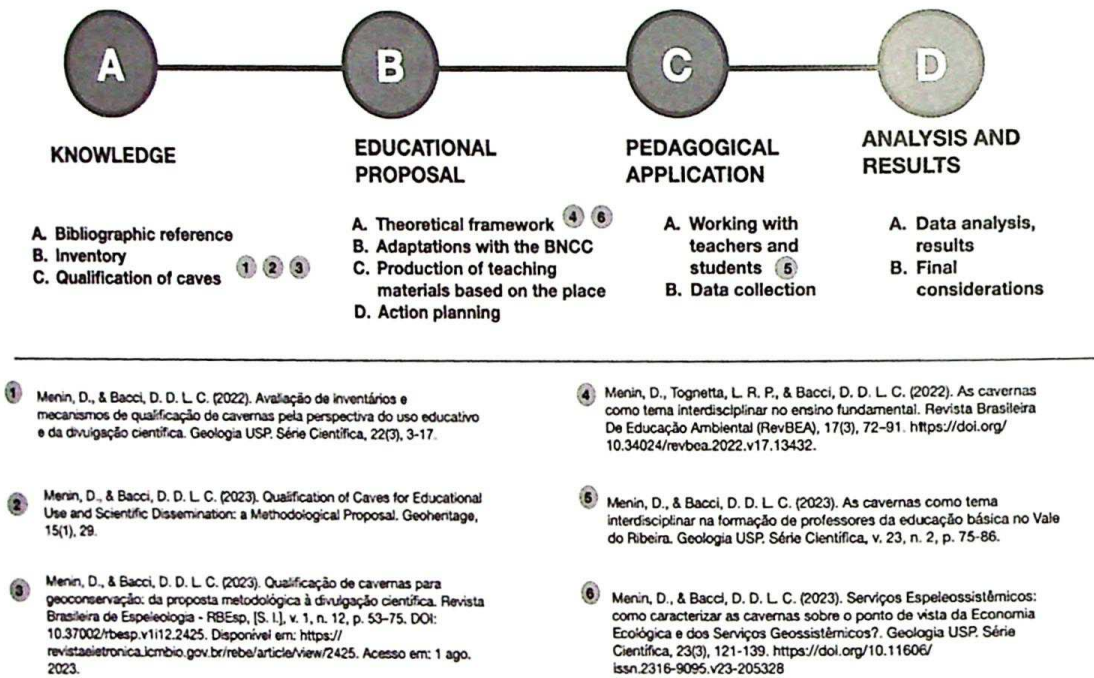


Figure 1: Structure of the research presented in this document, highlighting the four main stages carried out and the references to the published articles.

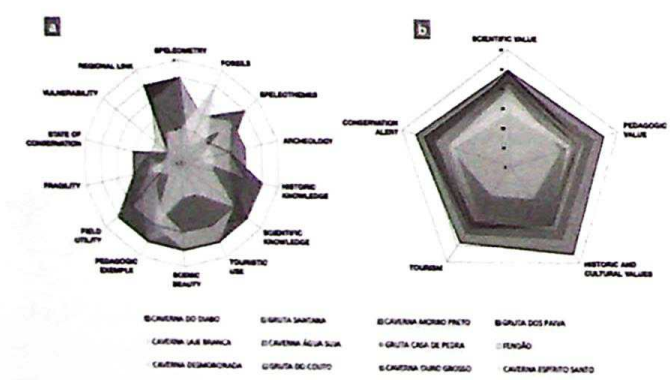


Figure 2: Averages obtained for each cave in relation to the 14 evaluated criteria (a) and weighted averages for each cave in relation to the Speleological Values and the Conservation Alert (b).



Figure 3: Examples of some place-based teaching materials created from data in the inventory. Above left, a panel with an interdisciplinary map of Devil's Cave. On the left, a collection of books about the main caves in the region, with maps, points of interest, photos, and geological information. Below left, one of the hundreds of photographs taken throughout the project that illustrate all the teaching material.

3. Discussions and Results

The present project addressed different stages of geoconservation strategies, focusing on knowledge, communication, and dissemination. The Inventory and the Cave Qualification Mechanism developed are linked to the diagnostic phase, while the pedagogical materials and the educational proposal contribute to the appreciation and dissemination of the speleological heritage.

Profile and Involvement of Teachers: 41 teachers participated, mostly women (82.9%), over 40 years old (56.1%), and with over a decade of experience in basic education (61%). The most represented subjects were Geography, Natural Sciences, Mathematics, and History. Although 65% reported active participation, 29% wished they had been more involved, citing lack of time and educational policies as obstacles.

Results on Sense of Place and Contextualized Education: Teachers' understanding of speleological heritage significantly improved, rising from 56% with average knowledge to 61.9% with good or excellent knowledge. Student engagement also grew: initially, 70% showed little or no interest in local caves, but by the end, 95% were moderately or highly engaged. Teachers noted that 80.9% of students actively engaged with the topic, suggesting a significant impact on recognizing the region's natural wealth.

Results on Interdisciplinarity: 95.3% of teachers identified opportunities to address caves in their subjects, demonstrating their high interdisciplinary potential. Furthermore, most found connections between their area and others, reinforcing the theme's applicability in the school curriculum and public educational guidelines (BNCC and

the Paulista Curriculum).

Resources and Results of Final Presentations: The culminating events analyzed different aspects, such as the resources used by students, the areas of knowledge addressed, and the level of interdisciplinary connection. The main resources used were displays, scenes, and models. The presentations covered a wide range of subjects, including History, Geography, Social Sciences, Tourism, Biology, Chemistry, and Physical Education. The analysis of knowledge areas highlighted the significant presence of arts, biology, and physical geography. Additionally, about 60% of the projects directly addressed geoconservation and geodiversity, while topics like tourism, biodiversity, and sports were also common. In 80% of the schools, more than one teacher was involved, reinforcing the interdisciplinary nature of the project.

The observation of final projects revealed that all presented examples from the local context, and 40% explicitly recognized the importance of place for students. Additionally, 80% of the projects valued the region, although only 20% connected this sense of belonging to environmental values.

Challenges Encountered: The main barriers to implementing the CIET Project in public schools included lack of time, changes in educational policies, curriculum standardization,

and communication difficulties among teachers. The continuity of the project will depend on the engagement of school leaders committed to contextualized education.

4. Conclusion

The research revealed that the participating teachers are experienced and represent various fields of knowledge, although topics such as place-based education and interdisciplinarity are still not common practices in schools. In the field of Geoconservation, the project addressed all the proposed stages and objectives, with a positive impact on students' understanding of the subject. The educational proposal (PECI) helped promote the recognition and appreciation of the place, with many students using local examples in their work. The integration of caves into the school curriculum favored the connection between disciplines and the development of creativity.

Despite the lack of resources in some schools, students overcame difficulties with enthusiasm and material adaptation. The project reinfor-

ced the appreciation of nature and critical reflection on environmental issues, aligning with national policies and stimulating ongoing education for teachers. The school administration demonstrated commitment to the project, and the coordinating teacher played a key role in leadership and interdisciplinary integration.

The main challenges included changes in educational policy, lack of time, and ineffective communication. Despite these, the project was successful in 2023, but its continuity will depend on maintaining support and commitment from school management. The educational proposal redefined traditional teaching, sparking students' interest and promoting the practical and engaging construction of new knowledge.

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