



## The use of trails as a didactic tool in Science and Biology teaching in Brazil: a systematic review

### O uso de trilhas como ferramenta didática no ensino de ciências e biologia: uma revisão sistemática

SILVA, Denise Santos da <sup>(1)</sup>; COSTA, Karine de Matos <sup>(2)</sup>; DANTAS, Janilo Italo Melo <sup>(3)</sup>

<sup>(1)</sup> 0000-0003-4985-5467; Universidade Estadual de Alagoas. Palmeira dos Índios, Alagoas (AL), Brazil. [denisesantodasilva82@gmail.com](mailto:denisesantodasilva82@gmail.com)

<sup>(2)</sup> 0000-0002-9212-8903; Universidade Federal de Pernambuco, Recife. Pernambuco (PE), Brazil, [karinecostabio@gmail.com](mailto:karinecostabio@gmail.com)

<sup>(3)</sup> 0000-0001-5763-4889; Universidade Federal Rural de Pernambuco. Recife, Pernambuco (PE), Brazil. [Janilo\\_melo@hotmail.com](mailto:Janilo_melo@hotmail.com)

The content expressed in this article is the sole responsibility of its authors.

#### ABSTRACT

The trails are routes in natural spaces that can be used as a didactic tool. Therefore, they are classified as non-formal spaces of teaching and learning. These spaces are important for the development of the contents of disciplines such as Science and Biology, for example. In this sense, we analyze the case studies published in the last 20 years to understand the importance of this didactic tool in the teaching and learning of Science and Biology. We conducted searches on online platforms for works that addressed the use of tracks in Science or Biology teaching in Brazil. We use the keywords in Portuguese and English on the platforms: Google Scholar and SciELO. We found a total of 212 results, with 42 studies selected by the established inclusion criteria. Among the disciplines that make use of trails stood out: botany, ecology, zoology, science education and environmental education. All the analyzed studies reported satisfactory results as a consequence of the use of trails: Overcoming botanical blindness, development of environmental awareness and scientific incentive associated with the disciplines. Thus, this work highlights the importance of the use of trails based on 42 published case studies evaluating this tool. This work contributes as a subsidy for teachers to expand the possibilities regarding the use of trails and, in this way, make use of this tool efficiently.

#### RESUMO

As trilhas são percursos em espaços naturais que podem ser utilizados como ferramenta didática. Por isso, são classificadas como espaços não-formais de ensino e aprendizagem. Esses espaços são importantes para desenvolvimento dos conteúdos de disciplinas como ciências e biologia, por exemplo. Nesse sentido, analisamos os estudos de caso publicados nos últimos 20 anos para compreender a importância dessa ferramenta didática no ensino e aprendizagem de ciências e biologia. Nós realizamos buscas em plataformas online por trabalhos que abordaram o uso de trilhas no ensino de ciências ou biologia do Brasil. Utilizamos as palavras-chave em português e inglês nas plataformas: Google Acadêmico e Scielo. Encontramos o total de 212 resultados, com 42 estudos selecionados pelos critérios de inclusão estabelecidos. Entre as disciplinas que fazem o uso de trilhas destacaram-se: botânica, ecologia, zoologia, educação científica e educação ambiental. Todos os trabalhos analisados relataram resultados satisfatórios como consequência do uso de trilhas: Superação da cegueira botânica, desenvolvimento de sensibilização ambiental e incentivo científico associado as disciplinas. Assim, esse trabalho realça a importância do uso de trilhas tendo como base 42 estudos de caso publicados avaliando esta ferramenta. Este trabalho contribui como subsídio para que professores possam ampliar as possibilidades quanto ao uso de trilhas e dessa forma, fazer uso desta ferramenta de forma eficiente.

#### Introduction

The discipline of Sciences in basic education from the point of view of the teacher, aims to explore information associated with environmental factors, human development and technological transformations among other subjects (Camargo & Blaszkowski, 2015). Biology is defined as one of the branches of natural science responsible for exploring knowledge about

#### ARTICLE INFORMATION

**Article process:**  
Submitted: 10/11/2021  
Approved: 11/05/2023  
Published: 03/07/2023



**Keywords:**  
alternative methods,  
biological sciences, didactic  
tour

**Keywords:**  
ciências biológicas,  
métodos alternativos,  
passeio didático.

different forms of life (Leite et al., 2017). The learning of Science, in elementary school, and Biology, in high school, allow the understanding of the biological structures that form all the biodiversity of our planet (Leite et al., 2017). For this biodiversity to be understood, it's necessary to dynamically construct different knowledge related to the constitution of living beings and their relationship with each other and with the environment (Camargo & Blaszkowski, 2015; Leite et al., 2017).

Although the contents addressed in the disciplines of Science and Biology are related to living beings and therefore are present in everyday life, these disciplines may involve complex contents that do not instigate the interest of students (Leite et al., 2017; Nicola & Paniz, 2016). In addition, the Biology and Science curriculum imposes a series of challenges for educators on different contents/concepts, which may be beyond what they can assimilate to assist in the learning process (Martins, 2005; Duré et al., 2018). To solve problems such as those mentioned above, didactic strategies began to be disseminated in the literature and in textbooks to assist both the student and the teacher in understanding complex contents related to the natural sciences (Miranda & Pelozato, 2011). Among the main methodological strategies used in the teaching of Science and Biology are the field classes with the use of "trails". The trails are paths or pathways that encourage logical reasoning, the ability to observe and reflect, providing approximation between individuals and the environment (Copatti et al., 2010; Rendeiro et al., 2012). For Machado et al., (2018, p. 136) "the interpretation of trails is a dynamic and participatory activity in which the teacher interprets the environment with the aid of support material, stimulating the participation of students, making them 'discoverers' of the natural environment".

Currently, the tracks are classified into three types: 1) interpretive (didactic, guided); 2) ecological (covering leisure and tourism) and 3) educational (in the sense of approaching the school curriculum) (Rocha et al., 2016). Despite the different classifications, when searching the literature, all three types are commonly used in the teaching and learning process in Brazilian schools, especially in disciplines such as Science and Biology (Rocha et al., 2016). The trails, regardless of the type, have played an attractive role in the learning process contributing to the development of students active in the construction of knowledge (Pin et al., 2018). This is because field practices, or other types of practical demonstrations, such as trails, can broaden the vision and questions of students about what is being studied (Câmara et al., 2016).

According to the National Curricular Parameters (*Parâmetros Curriculares Nacionais* - PCN), the tracks are perceived as a path directed to the development of conceptual and procedural contents in the teaching of natural sciences (Brasil, 2000). The trails can also function as an open-air laboratory for students because they enable the practice of certain contents seen in the classroom (Rendeiro et al., 2012). Given this, we analyzed the case studies

published in the last 20 years to discuss the importance of tracks as a didactic tool in the teaching and learning of Science and Biology.

### **Theoretical Reference**

The use of trails has been shown to be one of the innovative methods that has been commonly used in disciplines such as Science and Biology and other related areas in the teaching and learning process in Brazil (Souza et al., 2012). For Rendeiro et al. (p. 7) “a trail is nothing more than a path or road, usually narrow and winding between vegetation” (p. 7). However, more than a simple route, the trails have become an important didactic tool, because, nowadays, they have been used for different purposes, such as: contemplation of nature, for educational, playful, reflective, recreational activities, ecotourism activities and among other purposes (Costa et al., 2008; Copatti et al., 2010). These when carried out in the classroom, have contributed in a fundamental way in the process of construction of knowledge and human and social development of students.

The trails can usually be carried out by a trained guide and by the teacher or individual responsible, in which, through the route, the visitors/students are accompanied to observe, feel, experience, question, discover the facts related to the environment or can be interpreted by the visitors themselves through explanatory plates or leaflets (Araújo & Farias, 2003 apud Lima & Brabo, 2022).

The use of trails as a didactic tool can play a fundamental role for activities related to environmental education and especially for the development of environmental awareness (Souza, 2014). This is because through the use of certain trails, individuals have a direct contact with nature, going through analyzing and understanding it, being able to awaken the will to preserve and conserve nature (Souza, 2014). In this perspective, the trails, when well planned can provide environmental awareness, protecting the environment from the overexploited use of resources and certain environmental impacts (Costa et al., 2012).

In this perspective, for Costa et al. (2014) “the use of interpretive tracks in science teaching contributed positively to the construction of relevant scientific concepts, as they favor cognitive gains” (p. 1830). Despite being strongly related to environmental areas, the track is an effective way to work in an interdisciplinary way with students outside the classroom (Guimarães & Menezes, 2006). The ecological trails have great importance due to their direct relationship with environmental conservation, and provide behavioral changes in the human-nature relationship (SILVA et al., 2012). In addition, the tracks enable educational approaches that can be used both in high school, elementary, higher education and for other technical-scientific activities, providing knowledge and didactic clarification in general (Souza et al., 2012).

## **Methodological Procedure**

We used the systematic review method. For data collection, we searched for case studies with the use of trails as a didactic tool in the teaching of Science and Biology in Brazil, using the following keywords in Portuguese and English: “Ecological trail and sciences”, “ecological trail and biology”, “interpretive track and sciences”, “interpretive track and biology”, “educational track and sciences”, “educational track and biology”. We use the Google Scholar and SciELO platforms because they provide broad coverage of related works.

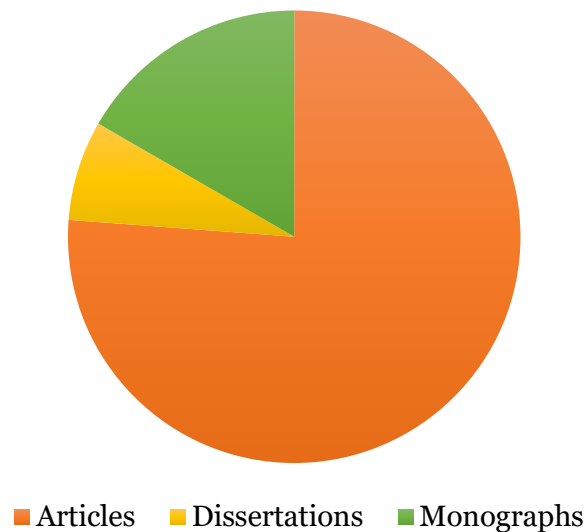
As inclusion criteria, we considered all studies published between 2000 and 2020. Such as: scientific articles, theses, dissertations, books, book chapters and academic abstracts. As exclusion criteria, only those studies that addressed the use of trails as a tool for practical classes in the teaching of Science and Biology, respectively in the modalities of Elementary School II and High School, and that had been carried out in Brazil were selected.

We analyzed the works and organized the information in tables considering three main characteristics: 1) Characterization (location where it was performed, year of publication, Segment of education (Elementary School II and High School), Category of the work (Scientific article, monograph, dissertation, thesis, chapter and book and et cetera); 2) Approach of trails in Science and Biology classes (contents addressed/purpose played by the use of the trails) and 3) Importance of the use of the trails (success obtained through the use of the didactic tool).

## **Results and Discussion**

We found a total of 312 works. After analyzing these studies, only 42 met the established criteria. Of the 42 papers analyzed, 32 consist of scientific articles, 7 monographs of course conclusion works and 3 master's dissertations (figure 1). Of these studies, 20 used tracks in science classes in elementary school and 22 in Biology classes in high school.

**Figure 1. Types of work between 2000 and 2020 that used tracks as a didactic tool in Science and Biology classes.**

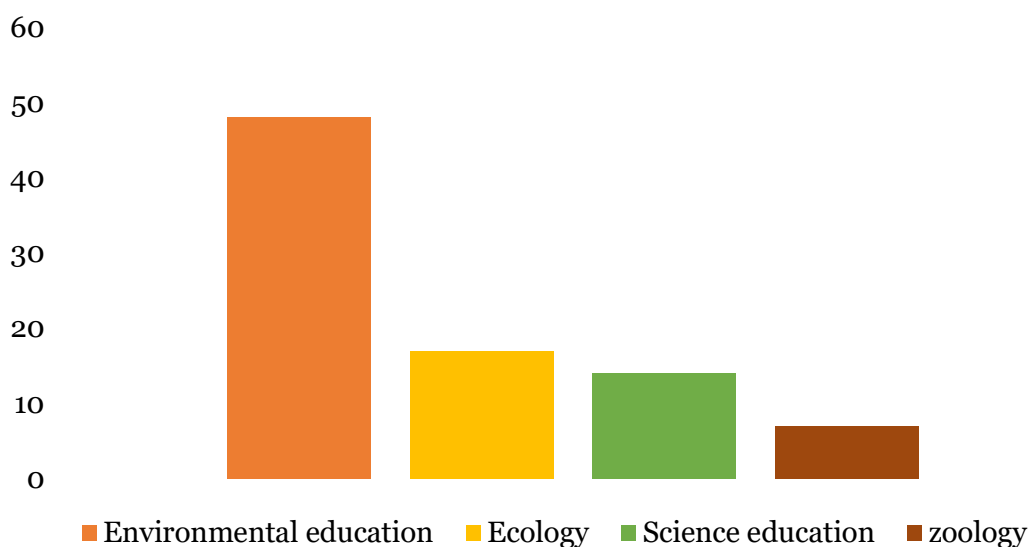


Source: The authors.

### **Contents related to the use of tracks in teaching and learning of Science and Biology in Brazil**

The contents belonging to the following subareas were highlighted: botany, ecology, zoology, scientific education and environmental education (figure 2). The trails proved to be an important tool in the learning of contents related to biodiversity and the environment. This is due to the fact that the trails provide the contact of individuals with local ecosystems natural elements (Santos & Silva, 2015 apud Dalmo et al., 2021). The tracks are also used for laboratory replacement, because in some cases, Science and Biology teachers approach the concepts in the classroom and use tracks as a practical class (Silva & Landim, 2012). In the teaching and learning of Science and Biology, practical classes are important for the development of critical reflection on the contents addressed, which is important for the development of a consciousness aimed at seeking solutions to environmental problems (Silva & Landim, 2012).

**Figure 2. Subareas with content covered in classes with tracks in the biology sciences teaching (works published between 2000 and 2020).**



Source: The authors.

Depending on the contents to be addressed, the realization of the trails can count on the help of different resources to stimulate the participation of the students, such as: explanatory posters, signs, photographs, folders and strategic stops with or without specialized guides (Câmara & Lima, 2007). These resources help in the interpretation of the students, facilitating the understanding of the contents addressed. Therefore, Eisenlohr (2013), states that good planning is essential for the success of the realization of the trails. It's important that the teacher has prior knowledge of the place where the trail is performed or receives assistance from a local field guide (Queiroz et al., 2017 apud Santos & Cunha, 2018). The teacher must also be creative to plan the use of the trail efficiently directing to the understanding of the contents of interest (Queiroz et al., 2017 apud Santos & Cunha, 2018). The trails, whether interpretive, didactic or ecological, are usually carried out in natural spaces, urban parks or public spaces, such as: conservation units, botanical gardens, national parks, local forests and zoos.

For Santos et al., (2011) apud Martins & Carvalho (2021), the trails made in natural spaces are justified, “first by the presence of new elements, such as trees and native plants, and, second, by the aspects revealed to the sensory organs, such as smell, beauty, color, bird song and wind” (p. 281). However, urban spaces are also being used to carry out recreational, tourist, scientific, contemplative and educational activities (Machado et al., 2018).

Most works that seek to approach tracks as a didactic tool, have referred to them as a strategy of “Didactic Sequence”. The didactic sequence is a pedagogical instrument planned

with combined activities to promote teaching and learning about a certain theme (Freitas, 2017). The didactic sequence helps students to solve one or more real difficulties on a specific topic. The realization of a didactic sequence by the teacher can count on the following factors: 1) definition of a theme to be worked as a didactic sequence; 2) define how the sequence will occur/how it will be performed; 3) realization of the didactic sequence and 4) evaluation of the didactic sequence to verify if the accomplishment of the activity reached the intended objectives (Vieira & Ohira, 2013; Freitas, 2017). Lopes (2017) investigated the applicability of conducting a didactic sequence, using an ecological trail with students from public schools in the state of Rio de Janeiro, in Brazil, to enable ecological and socio-environmental concepts. With the realization of this strategy, the author obtained satisfactory results, considering that all students expanded their knowledge about the subjects addressed. This happens because the realization of methodological strategies in a sequential and organized way has been shown to be efficient in promoting the understanding of contents (Vieira & Ohira, 2013).

### **Importance of the use of tracks as a didactic tool for the Science and Biology teaching in Brazil**

The fact that the tracks are being used as a didactic tool for different classes associated with subareas of the natural sciences, shows the important role of them for the teaching of Science and Biology. Through the analyzed works, we realized that the use of trails related to botanical contents is a key factor that can contribute as a way to overcome “Botanical Blindness”. This is a term used to represent the difficulty of individuals in perceiving plants in the environment and/or understanding their importance (Neves et al., 2019). This is because among the contents taught in the teaching of Biology, those of botany receive little enthusiasm from teachers and students (Coelho et al., 2016). For Coelho et al. (2016, p. 1), “although many reasons are pointed out for such disinterest, the big issue seems to be in the approach to the subjects inherent to the study of plants, resulting in tiring classes and unrelated to the daily life of the student”.

The use of trails in the teaching of botanical contents favors the dynamism and contextualization of the contents addressed, in addition to providing individuals with greater approximation and connection with plant biodiversity (Araújo, 2019). For example, Lazzari et al. (2017), when conducting an ecological trail aimed at teaching botany with students from a public school in the state of Rio Grande do Sul, in Brazil, verified a 55% increase in students knowledge about local plant diversity. In addition, Araújo (2019) when analyzing the use of an ecological trail to promote teaching/learning of botany with students of the third grade of high school in the state of Maranhão, in Brazil, evidenced an increase in the learning of botanical contents by students and a greater awareness about the preservation of natural resources. In addition, Freire (2019) when analyzing the use of ecological trail in the teaching of medicinal

plants, in the 2<sup>nd</sup> and 3<sup>rd</sup> year of high school of a school in the state of Piauí, in Brazil, verified that students actively participated in the class and that the use of the trail in the study of botany using medicinal plants, enabled the valorization of popular knowledge.

By promoting a direct interaction between the individual and the environment, the use of a trail related to environmental education classes contributes to the individual developing the adoption of values associated with the conservation of natural resources (Arancibia & Cavalcante, 2005 apud Paim & Botelho). This interaction can result in changes in people's relationships with nature both in the present and in the future (Arancibia & Cavalcante, 2005 apud Paim & Botelho). Other authors such as Souza et al. (2014), mention the use of trails as of fundamental importance for activities associated with environmental education, considering them as a method conducive to sensitization, observation and analysis of the environment through which the individual is passing, and may awaken in it the will to preserve the environment.

For Marinheiro et al. (2016), this is because the trails awaken the sense of responsibility over the actions of individuals in the environment. For example, Alves et al. (2018) when addressing the use of ecological trail as a proposal for teaching and learning in environmental education with elementary school students in the state of Amazonas, reported a strong stimulus of environmental perception by students, because during the trail students were able to identify possible environmental problems existing in the area and were reflective about sustainable actions that could be taken. Santos et al. (2011) apud Martins and Carvalho (2021), when analyzing the interaction of students with Special Educational Needs (*Necessidades Educativas Especiais* - NEEs) with the use of ecological and interpretive trails from the perspective of environmental education, verified that the use of trails provided the approximation of students with Special Educational Needs (*Necessidades Educativas Especiais* - NEEs) with the environment and with their own colleagues, that way also promoting affective and emotional development.

The use of trails in ecology classes is related to content about the environment, such as: food chain and its ecological relationships, diversity of biotic factors and abiotic factors of a natural environment (Câmara et al., 2016; Schwantes, 2008). In addition, we highlight the importance of the trails through the words of Pin et al. (2018, p. 3) "they are an attractive alternative in the process of learning ecological concepts, making students perceive themselves as an integral part and not mere spectators of the interrelations between man and nature". When used as a didactic strategy for zoology classes, the trails can promote activities associated with faunal characterization/identification that makes up a given area to: 1) demystify information about the animals to clarify historical and natural aspects of the species; 2) report the importance of the presence of certain species to maintain the ecological balance and 3) hold discussions on the importance of preserving certain species. For example, Andrade and Talamoni (2015) conducted an interpretive trail with second year high school students from



São Paulo state (Brazil) schools to demystify the fame of bats as malevolent beings. With the completion of this activity, many students reformulated their concepts about these mammals, and were more understanding about the ecological role and the importance that they have for the environment (Andrade & Talamoni, 2015).

It's important to mention that the use of trails as a didactic tool is an effective strategy to stimulate the "doing science" related to the nature of science in the disciplines of basic education. From the use of trails, students and teachers can be encouraged to investigate different problematizations associated with the areas, such as; problems associated with environmental and economic impacts, identification of plant and animal species, ecological relationships between species in certain areas, environmental perception, and even reflection on possible actions associated with the conservation of certain areas. This is important because the stimulation of scientific practice can promote critical, ethical, cultural, social and environmental habits to improve the quality of life of students and society. Field classes, such as the use of trails bring positive results also for teachers because, they feel stimulated for the development of interdisciplinary activities (Machado et al., 2018).

In general, we noticed that the use of tracks as a didactic strategy in Science or Biology teaching presented satisfactory results, regardless of the content addressed. This reinforces the statement of Pin et al. (2018) when mentioning that, all tracks play an attractive role in the learning process, promoting the protagonism of students in the construction of knowledge. In addition, they have become important didactic tools that facilitate the learning of certain contents and arouse better socio-environmental interests (Pin et al., 2018). In this sense, the choice to remove students from the classroom and take them to a non-formal space, such as the execution of a trail, when done with planning, is efficient to stimulate the participation of students in educational activities.

## **Final Considerations**

This review allowed the reflection of the importance of the use of tracks as a didactic tool for the teaching of Science and Biology. This didactic tool has provided the "breaking" of psychologically established barriers that make it impossible to learn content stereotyped as complex, for example: botany contents. The trails have proven to be an effective tool for educational spaces that have little or no practical resources - laboratory. It's also important to mention the contribution of the use of trails to the promotion of environmental awareness of individuals in society, because direct contact with natural resources enables the understanding of the importance of these resources and reflection on conservation/preservation. This work shows the importance of using trails as a didactic method based on published case studies, encouraging Science and Biology teachers to continue making use of the tracks in didactic sequences.

## REFERENCES

- Andrade, T. Y., & Talamoni, J. L. B. (2015). Morcegos, anjos ou demônios? Desmitificando os morcegos em uma trilha interpretativa. *Rev. Simbio-Logias*, 8 (11), 179-187. [https://www.ibb.unesp.br/Home/ensino/departamentos/educacao/revistasimbio-logias/morcegos\\_anjos\\_ou\\_demonios.pdf](https://www.ibb.unesp.br/Home/ensino/departamentos/educacao/revistasimbio-logias/morcegos_anjos_ou_demonios.pdf)
- Arancibia, S. D., & Cavalcante, A. M. B. (2005). Conservação da biodiversidade e da paisagem através de trilhas com sinalização para o ecoturismo, na Reserva Ecológica de Sapiranga, Ceará. *Anais da 57<sup>a</sup> Reunião Anual da SBPC, Fortaleza: Anais*, 2005 apud PAIM, A. & BOTELHO, R. G. M. (2022). Planejamento de trilhas ecológicas: estudo de caso no Rancho Sol Dourado, Nova Friburgo (RJ). *Revista Brasileira de Ecoturismo (RBEcotur)*, 15 (4) 775-801. <https://periodicos.unifesp.br/index.php/ecoturismo/article/view/12200>
- Araújo, D., & Farias, M. E. (2003). Trabalhando a Construção de um Novo Conhecimento Através dos Sentidos em Trilhas Ecológicas. In: *Anais II Simpósio Sul Brasileiro de Educação Ambiental*. apud das Lima, J. C., & Brabo, J. C. (2022). Trilhas Interpretativas: Proposta de Educação Ambiental para escolas de Quatipuru, Pará, Brasil. *Revista Exitus*, 12 (1), e022022-e022022. <https://doi.org/10.24065/2237-9460.2022v12n1ID1648>
- Araujo, R. S., & Farias, M. E. (2010). Trabalhando a trilha ecológica como estratégia de aprendizagem. *Revista Educação Ambiental em Ação*, 1(34). <https://www.revistaea.org/artigo.php?idartigo=927>
- Brasil. (2000). Secretaria de Educação Fundamental. Parâmetros Curriculares Nacionais: Ciências Naturais/ Secretaria de Educação Fundamental, Brasília, 2000. <http://portal.mec.gov.br/seb/arquivos/pdf/ciencias.pdf>
- Câmara, J. T., & Lima, A. R. (2007). O uso de trilhas ecológicas para trabalhar educação ambiental. *Revista Educação ambiental em Ação*, 1 (59), 1-19. <http://www.revistaea.org/artigo.php?idartigo=2679>
- Câmara, M. F., S., Bianchi, V., & Boff, E. T. de O. (2016). Trilha Ecológica como ferramenta de um estudo nas ciências na natureza e suas tecnologias. *Salão do Conhecimento, XXII Seminário de Educação Científica*. <https://www.publicacoeseventos.unijui.edu.br/index.php/salaconhecimento/article/view/6758>
- Camargo, N. S. J., Blaszkó, C. E., & Ujiié, N. T. (2015). O ensino de ciências e o papel do professor: concepções de professores dos anos iniciais do ensino fundamental. *Anais do XII Congresso Nacional de Educação*. <https://docplayer.com.br/14569504-O-ensino-de-ciencias-e-o-papel-do-professor-concepcoes-de-professores-dos-anos-inciais-do-ensino-fundamental.html>
- Coelho, A. N. (2020). *A importância das ciências nas séries iniciais do Ensino Fundamental*. <https://www.diarioamapa.com.br/cadernos/artigos/a-importancia-do-ensino-fundamental-conclusao/>.
- Coelho, R. T. P., Souza, R. L. M., Júnior, S. R. X., & Nazaré, L. O. (2016). Trilha ecológica capoeira do black (embrapa amazônia oriental) como ferramenta de apoio ao ensino de botânica. In *Anais do 67º Congresso Nacional de Botânica*, Vitória-ES. <https://www.embrapa.br/busca-de-publicacoes/-/publicacao/1059354/trilha-ecologica-capoeira-do-black-embrapa-amazonia-oriental-como-ferramenta-de-apoio-ao-ensino-de-botanica>

Copatti, C. E., Machado, J. V. V., & Ross, B. (2010). O Uso de Trilhas Ecológicas para Alunos do Ensino Médio em Cruz Alta-RS como Instrumento de Apoio a Prática Teórica. *Revista Educação Ambiental em Ação*, 9 (34), 1-10. <http://www.revistaea.org/artigo.php?idartigo=952>

Costa, E. S. A., Costa, I. A. S., Oliveira, K. S., & Melo, A. V. (2014). Trilhas interpretativas na área verde da escola como estratégia de ensino para aprendizagem de conceitos ecológicos. *Revista da SBEnBio*, 7(2), 1820-1831. <https://docplayer.com.br/3224836-Trilhas-interpretativas-na-area-verde-da-escola-como-estrategia-de-ensino-para-aprendizagem-de-conceitos-ecologicos.html>

Costa, M. M. S., Silva, E. B., & Meneses, L. F. (2012). Proposta de trilha ecológica como atrativo ecoturístico na área de proteção ambiental da barra do Rio Mamanguape – PB. *Turismo: Estudos Práticos*, Mossoró/RN, 1 (2), 105-117. <https://docplayer.com.br/73407314-Proposta-de-trilha-ecologica-como-atrativo-ecoturistico-na-area-de-protecao-ambiental-da-barra-do-rio-mamanguape-pb.html>

Costa, V. C., Triane, B. P., & Costa, N. M. C. (2008). Impactos ambientais em trilhas: agricultura × Ecoturismo - um estudo de caso na Trilha do Quilombo (PEPB - RJ). *Revista Brasileira de Ecoturismo*, 1 (1), 84-113. <https://periodicos.unifesp.br/index.php/ecoturismo/article/view/5843>

Duré, R. C., Andrade, M. J. D., & Abílio, F. J. P. (2018). Ensino de biologia e contextualização do conteúdo: quais temas o aluno de ensino médio relaciona com o seu cotidiano?. *Experiências em ensino de ciências*, 13(1), 259-272. <https://fisica.ufmt.br/eenciojs/index.php/eenci/article/view/231>

Freire, A. P. (2019). A utilização de plantas medicinais como ferramenta no ensino de Botânica em uma escola do Ensino Médio, Pedro II. [Dissertação de mestrado, Universidade Estadual do Piauí]. <https://sistemas2.uespi.br/bitstream/tede/306/2/Disserta%C3%A7%C3%A3o%20Completa.pdf>

Freitas, C. S. S. (2017). Trilhas ecológicas educativas em espaços não formais no Parque Natural Municipal do Curió, Paracambi -RJ. [Dissertação de mestrado, Universidade Federal Rural do Rio de Janeiro]. [http://18.229.168.129:8080/publicacoesArquivos/guandu/arq\\_pubMidia\\_Processo\\_190-2015.pdf](http://18.229.168.129:8080/publicacoesArquivos/guandu/arq_pubMidia_Processo_190-2015.pdf)

Guimarães, V. F., & Menezes, S. O. (2006). Uso de trilha interpretativa na educação ambiental: uma proposta para o município de Rosário da Limeira (MG). In: *II Fórum Ambiental da Alta Paulista* apud Lima, J. C. & Silva, D. E. L. (2022). O ensino de ciências da natureza com enfoque na botânica, anos finais, por meio de trilhas interpretativas. *Scientia Naturalis*, 4 (1), 406-414. <https://periodicos.ufac.br/index.php/SciNat/article/view/6104>

Lazzori, G., Gonzatti, F., Scopel, J. M., & Scur, L. (2017). Trilha Ecológica: um recurso Pedagógico no ensino de Botânica. *Scientia Cum Indústria*, 5 (3), p.161-167. <http://dx.doi.org/10.18226/23185279.v5iss3p161>

Leite, P. R. M., Andrade, A. O., Silva, V. V., & Santos, A. M. (2017). O ensino da biologia como uma ferramenta social, crítica e educacional. RECH- *Revista Ensino de Ciências e Humanidades – Cidadania, Diversidade e Bem Estar*, 1 (1), 400-413. <https://periodicos.ufam.edu.br/index.php/rech/article/download/4749/3855/>

Lopes, E. S. (2017). Os espaços não formais das trilhas ecológicas educativas como instrumento para prática de educação ambiental: uma proposta de sequência didática. [Monografia, Universidade Federal Rural do Rio de Janeiro]. <http://repositorio.im.ufrj.br:8080/jspui/bitstream/1235813/2761/1/Eliene%20dos%20Santos%20Lopes%20-%20Jul%202017.pdf>

Machado, J. L., Gomes, D. de O. B. G., & Batista, N. J. de C. (2018). Interpretação Ambiental como ferramenta Didática no Ensino de Botânica. *Revista Pesquisas Botânicas*, 1 (71), 135-146. <http://www.anchietano.unisinios.br/publicacoes/botanica/volumes/071/011.pdf>

Marinheiro, R. C., Oliveira, A. C. F. C. de; Oliveira, F. M. de; Emanuelle, M. F., Pessoa, A., Sarmiento, J. J. de A., (2016). Trilhas Interpretativas: um caminho para a Cidadania e a Educação Ambiental. *Revista Práxis*, 4 (7), p. 59-68. <http://dx.doi.org/10.18265/2318-23692016v4n7p59-68>

Martins, A. F. P. (2005). Ensino de Ciências: desafios a formação de professores. *Revista Educação em Questão*, 23 (9), p.53-65. <https://periodicos.ufrn.br/educacaoemquestao/article/download/8342/5998>

Miranda, S. P. & Pelozato, M. (2013). O ensino de ciências e biologia. *Maiêutica-Ciências Biológicas*, 1(1), 61-63. [http://publicacao.uniasselvi.com.br/index.php/BID\\_EaD/article/download/378/92](http://publicacao.uniasselvi.com.br/index.php/BID_EaD/article/download/378/92)

Neves, A., Bündchen, M., & Lisboa, C. P. (2019). Cegueira botânica: é possível superá-la a partir da Educação?. *Ciência & Educação (Bauru)*, 25 (3), 745-762. <https://doi.org/10.1590/1516-731320190030009>

Nicola, J. A., & Paniz, C. M. (2017). A importância da utilização de diferentes recursos didáticos no Ensino de Ciências e Biologia. *InFor*, 2(1), 355-381. <https://ojs.ead.unesp.br/index.php/nead/article/download/InFor2120167/98>

Alves, E., Oliveira, I. S., & Alves, C. N. (2018). Trilha ecológica pedagógica: um caminho para o ensino da educação ambiental em uma escola pública no município de Manaus (AM). *Revista Brasileira de Educação Ambiental (RevBEA)*, 13(2), 153-169. <https://periodicos.unifesp.br/index.php/revbea/article/download/2468/1535>

Pin, J. R., Rocha, M., Rodrigues, L., & Góes, Y. (2018). As trilhas ecológicas como espaços para o ensino de ciências: levantamento de dissertações e teses brasileiras. *Revista de Educação, Ciências e Matemática*, 8(2), 152-139. <http://publicacoes.unigranrio.edu.br/index.php/recm/article/download/4415/2739>

Queiroz, R., Teixeira, H., Veloso, A., Terán, A., & de Queiroz, A. G. (2017). A caracterização dos espaços não formais de educação científica para o ensino de ciências. *Revista Areté| Revista Amazônica de Ensino de Ciências*, 4(7), 12-23 apud Santos, S. C. S., & da Cunha, M. B. (2018). A pesquisa em espaços de educação não formal em ciências na Região Norte: o caso do Bosque da Ciência. *Amazônia: Revista de Educação em Ciências e Matemáticas*, 14(32), 160-173. <https://periodicos.ufpa.br/index.php/revistaamazonia/article/viewFile/5801/5274>

Rendeiro, M. F. B.; Júnior, M. A. S.; Terán, A. F. (2012). O uso de trilhas para o ensino de ciências. *ANAIS 2º Simpósio em Educação em Ciências na Amazônia e VII Seminário de Ensino de Ciências na Amazônia, Manaus—AM*. [https://cf3f4bd520.clvaw-cdnwnd.com/2coba43fff416133889ea9055cb6f97a/200000800-a2f3ba3ef6/2012\\_O%20uso%20de%20trilhas%20para%20o%20ensino%20de%20ciencias.pdf](https://cf3f4bd520.clvaw-cdnwnd.com/2coba43fff416133889ea9055cb6f97a/200000800-a2f3ba3ef6/2012_O%20uso%20de%20trilhas%20para%20o%20ensino%20de%20ciencias.pdf)

Rocha, M., Henrique, R., Quitá, C., Silveira, L., & Vasconcellos, V. (2016). Estudos sobre trilhas: uma análise de tendências em eventos de Ensino de Ciências e Educação Ambiental. *Acta Scientiae*, 18 (2), 517-530. <http://posgrad.ulbra.br/periodicos/index.php/acta/article/viewFile/1848/1623>

Santos, A. H.; Santos, H. M. N.; Júnior, B. S.; Souza, I. S.; & Faria, T. L. (2013). As dificuldades enfrentadas para o ensino de Ciências Naturais em escolas municipais do Sul de Sergipe e o processo de

formação continuada. XI Congresso Nacional De Educação. <https://docplayer.com.br/16958323-As-dificuldades-enfrentadas-para-o-ensino-de-ciencias-naturais-em-escolas-municipais-do-sul-de-sergipe-e-o-processo-de-formacao-continuada.html>

Santos, F. C.; & Silva, F. A. R. (2015). As trilhas ecológicas e o ensino de ciências: análises dos últimos anais dos encontros de Ensino de Ciências, Biologia e Educação Ambiental no Brasil. In: *Anais do X Encontro Nacional de Pesquisa em Educação em Ciências* apud Dalmo, J. D. D. O. M., Barreto, L. C. M. S., & de Araújo Marques, E. M. (2021). Trilhas interpretativas em unidade de conservação: espaço pedagógico para o ensino de ecologia. *Revista Brasileira de Ensino de Ciências e Matemática*, 4(2), 882-993. <https://doi.org/10.5335/rbecm.v4i2.11525>

Santos, R. D., & Almeida, R. D. C. (2011). Educação Ambiental e Trilhas Ecológicas: o caminhar para um futuro consciente e sustentável. *Revista Científica do Unisaesiano*, 1 (2), 265-276 apud Martins, J. H. B., & de Carvalho, D. A. F. (2021). A importância do uso de trilhas ecológicas no ensino de biologia: uma revisão de literatura. *Brazilian Journal of Animal and Environmental Research*, 4(1), 957-975. <https://doi.org/10.34188/bjaerv4n1-078>

Santos, C. M., de Melo Lopes, E. A., Passipieri, M., & Dornfeld, C. B. (2012). Oficina de interpretação ambiental com alunos do ensino fundamental na “Trilha do Jatobá” em Ilha Solteira, SP. *Revista Eletrônica de Educação*, 6(2), 271-288. <https://doi.org/10.14244/19827199218>

Schwantes, J. (2012). O trabalho em campo no ensino da botânica nos cursos de ciências biológicas: contribuições para o processo de ensino voltado à educação ambiental. [Dissertação de mestrado, Universidade Luterana do Brasil]. <http://www.ppgecim.ulbra.br/teses/index.php/ppgecim/article/viewFile/94/88>

Silva, M. M.; Netto, T. A.; Azevedo, L. F.; Scarton, L. P.; & Hillig, C. (2012). Trilhas ecológicas como prática de Educação Ambiental. *Revista Eletrônica em Gestão, Educação e Tecnologia Ambiental*, 5 (5), 705-719. <https://periodicos.ufsm.br/reget/article/download/4156/2800>

Silva, T. S., & Landim, M. F. (2012). Aulas práticas no ensino de Biologia: análise da sua utilização em escolas no município de Lagarto/SE. *Anais do VI Colóquio Internacional Educação e Contemporaneidade*. <https://ri.ufs.br/bitstream/riufs/8717/2/AulasPraticasEnsinoBiologia.pdf>

Souza, M. C. (2014). Educação Ambiental e as trilhas-contexto para a sensibilização ambiental. *Revista Brasileira de Educação Ambiental*, 9 (2), 239-253. <https://periodicos.unifesp.br/index.php/revbea/article/download/1807/1230>

Vieira, S. A. & Ohira, M. A. (2013). *Sequência didática para o ensino de briófitas*. In: Os desafios da escola pública paranaense na perspectiva do professor. [http://www.diaadiaeducacao.pr.gov.br/portals/cadernospede/pdebusca/producoes\\_pde/2013/2013\\_uenp\\_cien\\_pdp\\_shirlei\\_aparecida\\_vieira.pdf](http://www.diaadiaeducacao.pr.gov.br/portals/cadernospede/pdebusca/producoes_pde/2013/2013_uenp_cien_pdp_shirlei_aparecida_vieira.pdf)