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ORIGINAL ARTICLE

From the field practice of Biology's naturalistic tradition to the field days at school: distances and approximations

Da prática de campo da tradição naturalista da Biologia à aula de campo na escola: distanciamentos e aproximações

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Abstract: This study has a theoretical and, to some extent, essayistic nature, as it embarks on an investigative and reflective journey that deviates from traditional methodological constraints. The goal is to encourage dialogue between the traditional naturalistic field practices and the field-based lessons in biology education. We use the field practices of traveling naturalists from the sixteenth century as a point of reference, aiming to establish an interpretive time horizon for contemporary field classes. By investigating the attributes and progression of field scientific practices, we can assess their impact on biology field courses and how they differ from them based on the specific circumstances. Making connections between science and teaching can help to break away from the daily grind of pedagogical routines and facilitate the necessary reevaluation of biology field lessons.

Keywords: Biology education; Fieldwork; Research work; Traveling naturalists; Science education.

Resumo: Este estudo tem natureza teórica e, de certo modo, ensaística, visto que se lança a um exercício investigativo e reflexivo livre das amarras metodológicas tradicionais para propor um diálogo entre as práticas de campo da tradição naturalista e as aulas de campo do ensino escolar de biologia. Tomamos como referência as práticas de campo dos naturalistas viajantes a partir do século XVI, no intuito de traçar um horizonte temporal interpretativo em relação às atuais aulas de campo. Ao apresentar as características das práticas científicas de campo e sua evolução, podemos analisar como as aulas de campo de biologia foram se constituindo, inspiradas nessas práticas e se diferenciando delas pelo contexto em que são desenvolvidas. Fazer correlações entre o campo da ciência e o do ensino pode contribuir para se tomar distância do cotidiano da prática pedagógica e propiciar a ressignificação necessária das aulas de campo em biologia.

Palavras-chave: Ensino de biologia; Pesquisa de campo; Estudo de campo; Naturalistas viajantes; Ensino de ciências.

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Introduction

By looking at biology as a product of modern science, one can see how it has branched out into other disciplines that deal with specific areas of biological knowledge. These branches contain two major research traditions that, while not mutually exclusive, deal with different methodological practices and research interest. The first type is that of the naturalist, who is the inheritor of natural history and whose primary method of research is conducted in the field. This category includes disciplines like botany, ecology, paleontology, and zoology. The second tradition is that of functional biology, which is closely associated with laboratory experiments. This tradition encompasses the study of microorganisms, physiology, molecular and cellular biology, and genetics (Araújo, 2001).

Studies on the emergence of modern science, its origins, and historical developments reveal shifts in its pursuit that have an impact on epistemological perceptions about how to read the world and the development of scientific and technological strategies for this reading, as well as on the social interests and power dynamics that have fueled its advances over time. A look through the lens of the history of science[1] allows us to uncover, even subtly, the epistemological and methodological openings/changes that shaped natural history and, in turn, biology.

The expeditions undertaken by naturalists, dating back to the sixteenth century, pivotal role in shaping the methods, mindset, and ethos of scientific inquiry, including the field of natural history and its emphasis on meticulous observation and analysis. This culture of precision during the post-Renaissance era played a crucial role in establishing the scientific legitimacy and validity of modern scientific thought (Fetz, 2019). Natural history employed systematic classification and fact-based observation, which had a significant impact on naturalistic biology.

In this article, we delve into the naturalistic tradition or natural history without aiming to reconstruct a narrative about the dawn of biology. Our objective was to theoretically investigate the ways of implementing, that is, the actual field practices of the itinerant naturalists, who worked in the field between the sixteenth and nineteenth centuries, a period characterized by a greater degree of systematization and production of scientific knowledge based on this type of fieldwork.

This incursion implies that we should consider the field classes of today as a remote manifestation of the conventional field methodologies employed by naturalists. That is, by drawing a parallel, albeit virtual, between the field scientific practices of naturalists and field classes in biology education, we can observe certain traits that were – so to say – inherited from the former to the latter. At the same time, this highlights the influence of the specific time and context that sets them apart.

Based on approximations and distances in the methods and perspectives of field practices so distinct in historical and spatial terms, we propose the hypothesis that field classes continue to embody key elements that have contributed to the development of scientific knowledge. By examining these aspects, we can derive pedagogical implications that are relevant in the present context.

[1]In this article we refer to authors of the history and philosophy of science, but the work is not part of these areas, since our objectives are aligned with research on pedagogical practices.

This is a theoretical and, in a sense, an essay-like work, as we engage in an investigative and reflective exercise devoid of traditional methodological constraints. It is certain that it still retains much of what we learn to do and say in academia, but it ventures to seek in historical and philosophical references (of which we are not experts) foundations of a theme that touches us in practice: the field days. Clarification is required regarding this, as we, the authors, are Brazilian teachers of Biological Sciences, and field trips are increasingly seen as a luxury available only to those in higher social strata. Getting involved in this writing field and attempting to establish the theoretical underpinnings of biology field classes is a way to support the role of the professor as a researcher and the use of research as a tool for social and educational change.

The text is structured into three distinct sections. First, we approach the naturalistic tradition and field methods, forging a path through its traits and historical context. The subsequent section provides an examination of field classes as an educational practice within the realm of biology. In addition to the specific literature consulted, the argumentation also owes its debt to our experience with this type of class in elementary and advanced education, encompassing both research practices and pedagogical aspects in nature. It is worth noting that the precursor of this study was the doctoral dissertation of the first author, who recognized the necessity to further explore the theme. In the final section of the text, we compare and contrast the naturalists' scientific methods with those currently used in the field of biology.

The naturalistic tradition and field practices

Biology, as we know it, traces its origins back to the field of natural philosophy. During the 16th and 17th centuries, significant transformations occurred, including a departure from the teachings of Aristotle that had dominated the intellectual landscape throughout the Middle Ages. For Grant (2009), the emergence of religious and political contexts towards the end of this era, along with significant technological advancements like the invention of the Gutenberg press and the exploration of continents and cultures, as well as the creation of tools such as the microscope and telescope, and the influence of the Enlightenment on the sciences and the arts, particularly through a reexamination of Greek philosophy, all served to challenge the limitations of natural philosophy from an Aristotelian standpoint.

The significant explorations of the New World introduced numerous plant and animal species to Europe, which subsequently became integral components of botanical gardens, museums, and zoos. As a result of these discoveries, new classifications were required, and the development of the microscope furthered our understanding of the diversity of life. These changes transpired within the framework of an expanding realm of navigational techniques and the significant growth of European territories. Moreover, they played a pivotal role in elevating the tangible world as the primary basis for systematic reasoning. It is essential to note that the trips brought empirical evidence that challenged the closed worldviews imposed by the dominant religious system of the time.

> Epistemic comfort was thus shaken by the introduction of empirical uncertainties experienced through travel. The evidence brought by travelers proved or refuted old theses, favoring the consolidation of changes introduced since the end of the Middle Ages. The connection between travel culture and scientific culture was of fundamental importance for the transformation of the curiosity culture into a culture of precision (Fetz, 2019, p. 42, our translation).

The bet made on the journeys, along with the materials and reports that travelers brought, was at the heart of the process of increasing knowledge production. The journey was the cause and effect of a worldview that needed empirical evidence to consolidate. Precision instruments, such as measurement and calculation tools, have greatly aided navigation, enabling travelers to efficiently reach far-flung destinations. The successful conclusion of the trip added to the body of evidence upon which a more rational and empirical worldview could rest (Fetz, 2019).

As noted by Augustin (2009), the evolution of travel and travel reporting can be traced back to the advancement of epistemology during the early stages of modern philosophy. Despite their distinct social roles, the goals of the traveler, the explorer, and the scientist shared a growing similarity: all aimed at exploring the unknown through systematic frameworks of comprehension rooted in empirically driven curiosity.

Measurement techniques were developed as a result of the need to simplify the accumulation of knowledge (both material and symbolic) acquired since the conclusion of the Renaissance. In a sense, precision can be comprehended as a mechanism that demystifies the culture of curiosity. Expeditions were pivotal in this procedure. According to Wolfzettel (1996), the Renaissance traveler played a central role in transforming curiosity into a social philosophy based on precision; moreover, they were responsible for the demarcation between the divine and the mundane, which allowed for the social division of the work of thought between the theologically speculative, reserved for divine mysteries, and the systematic analysis of empirically observable regularities, especially natural phenomenology.

The natural historians or naturalists, as they are also known, distinguished themselves based on their activities into two groups: the traveling naturalists, also known as naturalist travelers, field or action naturalists, who accompanied expeditions and collected specimens; and cabinet naturalists, who were devoted to laboratory work or research centers such as museums, botanical gardens and zoos (Kury, 2001).

Naturalist travelers were generally supported by the royal crown and/or scientific institutions, and their roles included gathering data to inventory the natural riches discovered, as well as dealing with political issues about territories, trade, and the distribution of natural products to settlers, frequently acting as intermediaries between the interests of the colonizers and the colonized (Leite, 1995).

The 19th century in Brazil is characterized by a vigorous scientific output from naturalist travelers (Souza, 2019)[2]. Since trips sponsored by royal crowns had more of an interest in showcasing the beauty and characteristics of the inhabitants of the new lands and satiating the curiosity of the settlers than in producing scientific knowledge within a methodological rigor, Padoan (2015) argues that after Brazil's independence, there was more freedom of scientific research for travelers. The most independent travelers or those who were sponsored by scientific institutions, on the other hand, had a greater interest in techniques and systematization as well as a desire to produce scientific knowledge.

There are three stages in the formation of travelers' field practices: pre-field, field, and post-field. The first phase was the process of getting prepared for the trip, which included getting funding from the organizations that sponsored them and buying the

[2]Two important scientific institutions were founded in Brazil in the 19th century, the Botanical Garden in 1808 and the National Museum in 1818. The creation of these research centers points to the interest in knowing and inventorying the species of Brazilian fauna and flora.

supplies needed for collecting, identifying, and preserving the collected data. Based on the knowledge gained by those who had already traveled as naturalists, a variety of instructional materials were developed to help future travelers. These manuals provided significant guidelines to be adhered to during their pilgrimages, alongside illustrations and writings of the natural world (Pataca, 2011).

The formulation of protocols and the creation of instructional guides were customary procedures carried out by both scholars and individuals affiliated with museums. These endeavors were designed to safeguard the integrity of the specimens gathered during expeditions, ensuring their optimal preservation upon arrival at the museums (Pataca, 2011). Examples of notable publications include the book *Instructio peregrinatoris*, which was published in 1759 by Carlos Linnaeus. Additionally, there is the manual titled *Method de collect, prepare, remit and conserve natural products*, crafted in 1781 by naturalists of the Royal Ajuda Museum in Portugal.

At the time, a large portion of the knowledge acquired through travel generally arrived in the form of paintings, engravings, samples of plants, animals, and minerals, cultural artifacts, and others. According to Fetz (2019), these materials were organized based on their objectives: (1) the establishment of an encyclopedic system for the purpose of cataloging and categorizing evidence; and (2) the development of a universal style of thought to structure the entirety of the world into a grand narrative.

The collections were samples gathered by these roving naturalists and kept in locations solely devoted to the study of natural history, such as offices, museums, and gardens. Following the expeditions, these collections were carefully handled by historians within a minimally controlled environment, resembling the early stages of the contemporary laboratory (Fetz, 2019).

A series of procedures were repeated in the field, including observing, collecting, preparing, and mailing. The manuals proved to be valuable during these periods, yet the techniques were modified based on the prevailing environmental conditions. Another common practice involved the documentation and depiction of animals or plants within their natural surroundings, creating what Pataca (2011) refers to as the *Nature Theater*. This form inaugurates a novel approach to fieldwork, wherein the traveling naturalist's duty entailed meticulous and thorough observation coupled with precise documentation of living organisms in their various ecological and adaptive contexts. The purpose of such collections was to effectively portray such aspects (Caponi, 2006; Kury, 2001; Padoan, 2015).

It is worth noting that the studies conducted by Charles Darwin were significant in altering the practices of naturalist explorers. As per Caponi's (2006) findings, prior to the contributions made by Darwin, field naturalists held the responsibility of collecting specimens. Their primary objective was to carefully gather and send well-preserved samples to the naturalist's cabinet. These samples were accompanied by detailed descriptions, enabling the necessary laboratory analyses to be conducted. A proficient field naturalist must possess the skills of illustration, detailed description, species identification, and preservation techniques to ensure the intact arrival of specimens in museums. The Darwinian revolution ushered in a paradigm shift for traveling naturalists, transforming them from mere collectors of materials to diligent observers of the intricate relationships among organisms in their native habitats (Faria, 2010).

The observations were accompanied by detailed accounts of the experiences as well. Many naturalists documented their field trips in diaries[3], which included meandering thoughts, impressions, emotions, and the situations that they encountered. The beauty of nature, its creative ability, and its dangers were often portrayed poetically. Although did not directly compose the scientific work disseminated by the authors, the aesthetic practice experienced was part of being in the field and was valued by them in their records.

> Thus, the scientist who became a traveler chose not only to see with his own eyes but to hear and feel with his own body the phenomena there where they happen. Perhaps one of the hesitations of romantic science resides there, since, if, on the one hand, the romantic traveler produced science on-site, on the other, ended up specializing in the precise recording of sensations and phenomena, in line with the scientific methods established at the time. (Kury, 2001, p. 879, our translation).

The aesthetic qualities and depictions found within the accounts of the itinerant naturalists were shaped by the ideals of the Romantic movement. Romanticism brought a more expansive perspective to the scientific methodology employed in the field, as well as to the study of natural history. For historians more influenced by romanticism, "[…] the totality of nature cannot be found through the dissection of the parts. His gaze turns to transformation, refusing the static fixation of living beings for the knowledge of those beings" (Falcão, 2016, p. 1241, our translation).

During the excursions, regardless of the excellent control and techniques employed, the traveling naturalist was constantly exposed to the unpredictable. In contrast to the possible control in a laboratory, naturalists in an open environment were at the mercy of climatic, topographic, and landscape conditions that could even pose health risks and alter the expectations of the journey (Leite, 1995).

Kury (1998) contends that in the mid-nineteenth century, with the advent of Auguste Comte and Herbert Spencer's positivism, a new paradigm for the work of the traveling naturalist emerged, one that is more focused on the observation and measurement of phenomena and is divorced from tradition and romantic heritage[4].

The compilation of data acquired through collections, reports, drawings, and observations facilitated the progression of activities within the cabinet in a more precise and methodical manner. In the early 20th century, offices were transformed into laboratories, enabling the manipulation of variables such as temperature, climate, pressure, and more. This facilitated the conduct of experimental procedures (Fetz, 2019). Over the century, various techniques and instruments have been developed in these domains, leading to a refinement in our understanding of knowledge production within the field of biology.

The traveling naturalists may have gathered the strange in the vastness and mystery of the unknown, but it was in the laboratories where they could organize and analyze the data in greater depth. With the advent of technological advancements and theoretical investigations, field practices have evolved to become more focused, honing in on specific objectives in their explorations. The exploration of specific species of disease-transmitting insects, or the gathering of in-situ DNA from endangered species, exemplify the myriad of potential avenues for investigation. Field practices persist in conjunction with laboratory practices.

[3]Naturalist travelers more interested in investigating human cultures gave rise to what would become anthropology and their way of working, the use of field diaries, for example, was consolidated within this science.

[4]It is important to highlight that the sequential presentation of the romantic and positivist influences that formed natural historians, in the text, fulfills a role only didactic, because both romantic and positivist coexisted.

The twentieth century was a pivotal era that witnessed the emergence of hyper-specialization of science, along with the adoption of novel technologies such as biotechnology, nanotechnology, and the rapid progress of technoscience. The scientific progress during the twentieth century is characterized by the prominence of specialized laboratories, research groups, collaborative networks, and substantial funding (Latour, 2012). The discovery of the structure of DNA sparked a profound transformation in the field of biology and played a key part in establishing it as an experimental science (Goodson, 1997; Silver, 2008).

As a scientific field, biology gained recognition as a significant discipline in the mid-20th century due to advancements in molecular biology. During this time, it began to assert itself as a well-defined body of knowledge, built upon identifiable practices and validated through scientifically accepted criteria. Biology encompasses a diverse field centered on the phenomenon of life; thus, it is customary to refer to the different disciplines that comprise it as the biological sciences.

In terms of field practices, numerous technological resources and innovative techniques have been employed to enhance and streamline fieldwork. In the present day, it has become feasible to observe the real-time locomotion of an organism, capture video footage, and transport laboratory equipment to the field, all without necessitating the transportation of said organism to the laboratory. In the realm of field collections, biology courses have endeavored to steer clear of animal mortality practices by choosing collections that are subsequently followed by release for educational purposes. Other shifts in attitude that can be seen in the context of a biology course include not building entomological boxes or capturing animals for taxidermy.

This set of measures stems from discussions surrounding the generation of scientific knowledge and its societal and environmental implications, which gained prominence in the mid-twentieth century. Consequently, there has been an increasing focus on the ethical aspects of scientific research, particularly those involving the utilization of living organisms.

The field of ethics has helped us reflect on the responsibilities, implications, and risks associated with the production of science and the search for practices that can ensure respect for nature. However, as Lacey (2008) points out, the uses of science must be also oriented toward this goal.

As we embark upon the 21st century, it becomes apparent that field practices have largely remained unchanged. However, we now have the advantage of utilizing modern networking techniques that allow researchers from various global locations, as well as public and private institutions, to collaborate on field practices. Additionally, these practices are further supported by the funding and coordination of technology production and research in highly specialized laboratories. The significance of fieldwork in the field of biological sciences has been amplified and revitalized. There is a growing interest among diverse social sectors and areas of knowledge in comprehending the intricate interactions that exist in nature. Additionally, there are novel perspectives on biodiversity and biotechnologies, as well as a need to monitor the ever-evolving connections between humans and the environment, which are increasingly intertwined with technoscience.

As expected, so many scientific, technological, social, and cultural transformations result in changes in teaching, prompting researchers and teachers in the field to rethink objectives, curricula, and pedagogical practices related to the processes of teaching and learning science in schools (Carvalho, 2015; Goodson, 1997; Krasilchik, 2019).

Field lessons in biology teaching

While certain literature argues that field classes are the direct successors of the naturalistic tradition (Compiani; Dal Ré Carneiro, 1993), from a practical and pedagogical standpoint, we did not observe a direct correlation between the methodologies employed by naturalist explorers and field classes in the context of science and biology education. However, it is important to acknowledge that revisiting the naturalistic tradition can provide us with a fresh perspective on the field practices that we implement in educational institutions, such as schools and universities.

The field classes in this context are understood as didactic methods that are conducted beyond the confines of the traditional classroom, frequently in outdoor environments and/or areas that are deemed to be natural – the school grounds. And we know the significance placed on field classes as a valuable component in the education of students, albeit occasionally being conducted to a lesser extent (Fernandes, 2007; Nunes; Dourado, 2009; Pegoraro, 2003; Trevisan, 2021; Viveiro, 2006). It is important to note that we make this statement contextualized in the Brazilian reality. In ethnographic work accompanying field classes in schools and a degree course in biological sciences, we were able to ascertain the difficulties and efforts necessary for its realization (Silva, 2019). In particular, the areas of biology and geography often use outdoor environments as a practical open-air laboratory (Pegoraro, 2003), both to put into practice theoretical knowledge seized in the classroom, as well as a strategy or methodology to generate new knowledge and skills in the field itself.

In the literature on the subject, there are a variety of names to designate these classes. However, there is a lack of consensus on their distinctions. In Brazil, on the one hand, they are referred to as excursions, nature walks, supplementary lessons, field activities, intermediate studies, visits, pedagogical tours, and educational tourism, for example (Bitar, 2010; Fernandes, 2007; Rocha; Salvi, 2011; Viveiro, 2006). On the other hand, field trips go by many names in English, including field trips, education outside the classroom, environmental studies, fieldwork, school excursions, school journeys, outings, expeditions, outdoor education, and the field day (Behrendt; Franklin, 2014; Fernandes, 2007).

Similar to the rich assortment of names that distinguish the field classes, the same can be observed regarding the locations in which they take place: the educational institution and its surroundings, the neighborhood, museums, parks, nature reserves, public squares, and so forth. In essence, any setting beyond the confines of the traditional classroom possesses the capacity to serve as a valuable backdrop for field classes. In contrast to the naturalistic tradition, the concept of the *field* in the field class encompasses more than just natural spaces. The concept is utilized in various educational settings, as noted by Pegoraro (2003), with a particular preference among science/biology and geography educators for utilizing natural environments featuring picturesque landscapes for conducting field-based lessons.

Characterizing field classes requires piecing together a chunk of the history of science and the various biology disciplines. Goodson (1997) emphasizes the contemporary chronicle of these fields in the curriculum, in particular during the mid-nineteenth century in Europe. As per the author's perspective, the initial stages of science education primarily revolved around religious understanding and moral improvement. In this context, the utmost importance was placed on precise observation and accurate depiction of natural phenomena. Throughout its history, the teaching of science has assumed an academic structure, as established by universities, and has maintained a separation from common language and practical applications. Henceforth emerges a scholarly pedagogy intertwined with the erudite intelligentsia, which esteemed laboratory sciences above alternative branches of scientific inquiry. Science education in the past often adhered to an elitist approach, placing significant emphasis on laboratory work while neglecting outdoor field experiences, for example. Krasilchik (2019) portrays this panorama of changes in biology teaching and the influence of the social, political, and economic context on the formation of the curriculum and educational practices.

In the Brazilian educational realm, during the emergence of the New School movement in the early 20th century, the nation successfully organized a project to formalize field classes, then referred to as environmental studies, as a pedagogical initiative. According to Pontuschka (2004), scholasticism can be traced back to its antecedents, one of which was the concept of anarchist schools. These schools sought to encourage students to not only learn within the confines of the classroom but also to actively observe and describe the natural and social environment surrounding them. By doing so, students would be able to reflect upon the existing inequalities and injustices, ultimately fostering a desire for positive changes in the pursuit of justice.

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In the Brazilian university context, the longstanding tradition of incorporating field classes and expeditions into life sciences courses can be traced back to the 1960s, when these activities became an integral part of both bachelor's and licentiate degrees. It is worth mentioning that the first course for the training of biology professionals was created in 1934, at the Faculty of Philosophy of the University of São Paulo, called Natural History. “From 1963, the Natural History course was extinguished due to its unfolding into two independent courses: Geology and Biological Sciences – Bachelor's Degree and Bachelor's Degree – Medical Modality” (Tomita 1990 *apud* ULIANA, 2012, p. 3, our translation). University curricula regulated the direction of biology instruction in K-12, with an initial focus on laboratory science. It is crucial to emphasize the significance of the Brazilian Institute of Education, Science, and Culture (IESC) and the impact of foreign initiatives like the Nuffield Institute and the Biological Sciences Curriculum Study (BSCS) in shaping the curriculum and methodology of the Brazilian academic field (Krasilchik,

2019). During this period marked by the Cold War and the Space Race, these educational institutions advocated for a more pronounced emphasis on experimental methodologies in both the classroom and laboratory settings.

In contrast, there were proponents like the Study Group on Education and Field Biology, who aimed to challenge the notion that field studies were any less scientific or indispensable compared to experimental methodologies. Nevertheless, these practices were primarily limited to ecological themes and were not highly regarded within the school setting.

In the field of curriculum and curriculum policies, field activities gained space in national texts only in the late 1990s[5] with the promulgation of the National Curriculum Parameters for Basic Education (Brasil, 1998), and again in the early 2000s, with the publication of the National Curriculum Guidelines for Secondary Education (OCEM) of Nature Sciences, which included the *study of the environment* as an important tool for environmental reading (Brasil, 2006). In the training of biologists, the national guidelines inform that the curriculum should prioritize compulsory field activities (Brasil, 2001).

In more recent times, the National Curriculum Guidelines for Basic Education have emphasized the significance of field classes. These guidelines advocate for the promotion of curricular development in various locations, thereby extending the duration and scope of educational experiences beyond the confines of the school (Brasil, 2013). Similarly, the Common National Curriculum Base serves as a guiding framework for implementing extracurricular activities aimed at fostering active participation, enhancing understanding of the world, and promoting community involvement (Brasil, 2018).

From a didactic-pedagogical perspective, the field class is typically categorized into three distinct phases: the pre-field, the field, and the post-field analysis. Usually, the pre and post-phases take place in the classroom or on school grounds, serving as opportunities for contemplation regarding the objectives of the field class and the subsequent assimilation of this experience (Davidson; Passmore; Anderson, 2010). The time spent in the field, whether it be a single day, a shift, or multiple days, should result in a novel educational opportunity. A prevalent practice in biology education involves the inclusion of field classes that last a day or are followed by multiple visits, all without the requirement for overnight accommodations. These habitats are typically found close to educational institutions and are accessible to the public, including parks, zoological facilities, nature reserves, horticultural gardens, and scientific museums.

Field classes with extended durations, in general, are orchestrated by educational or pedagogical tourism enterprises, which first proliferated in Brazil during the 1980s. The company provides comprehensive arrangements for group itineraries, including logistics for accommodations, transportation, and meals. Due to the cost of employing these agencies, this tourism focuses more on private schools (Fernandes, 2007).

In regards to the objectives of field classes, scholarly literature emphasizes that they offer a *first-hand*[6] experience with tangible components, such as ecosystems, living organisms, and biological processes. This hands-on experience enables students to develop perceptions and sensations that cannot be replicated in a traditional classroom setting. This particular experience possesses the capability to incite curiosity and drive

[5]It is noteworthy that in the 1990s there was a great diffusion in the country and in the world of the concept of sustainable development and environmental education, with the structuring of national and international standards of environmental protection.

[6]Knowledge acquired by the student from direct experience.

in the realm of science and biology education, as well as foster the enhancement of skills in observation, perception, and social interaction (Behrendt; Franklin, 2014; Fernandes, 2007; Fracalanza; Amaral; Gouveia, 1986; Fuller, 2006; Magntorn; Helldén, 2005; Oliveira; Assis, 2009; Seniciato; Cavassan, 2004).

Trevisan and Alves (2013) identify three dimensions of motivation that may be present in field classes. The first is related to the opportunities made possible by the activities: discussions and analyses create a framework that broadens how reality is read. The second dimension is the quality of the learner's interactions, and in this sense, the teacher's role in drawing the learner's attention to the connections between prior knowledge and the new material is crucial. The third component encompasses the value dimension of acquired knowledge and the potential of contextualization to prompt students to reassess and potentially modify their attitudes. For the authors, the quality of social interactions as well as the characteristics of the context in which these interactions take place are critical for scientific learning.

Upon examining the aspirations of the educators responsible for crafting these courses, Nunes and Dourado (2009) discern the aims of fostering a heightened reverence for the natural world and cultivating a scientific mindset through the practices of observation and exploration. In this context, the field classes would aim to achieve both environmental education and the development of scientific concepts of nature.

Regarding environmental education in science education, the existing literature underscores the valuable role that field courses are carried out in natural settings. These classes possess a more reflective nature and provide valuable opportunities for those involved to establish meaningful connections with nature. This, in turn, contributes to the development of personal perspectives and ethical and aesthetic sensitivities that are directed toward the appreciation of the environment (Hoisington; Sableski; Decosta, 2010; Lestinge, 2004; Lucas, 1980; Neiman; Ades, 2014; Pegoraro, 2003; Seniciato; Cavassan, 2004).

Nascimento Júnior (1996) argues that field trips are one of the best ways to reconstruct a concept of nature outside of the reductionist and mechanistic scientific paradigm. For the author, the knowledge gained during the excursions would facilitate an integrated and reciprocal understanding of the relationship between culture and nature. In his words, "[…] stones, plants, animals, men and history are mixed and reveal themselves, therefore, building the stories of the region" (Nascimento Júnior, 1996, p. 103, our translation).

In this sense, field classes assume the necessity of *immersion in the environment*, although this is not the sole requirement for optimal learning outcomes. Many authors (e.g., Fernandes, 2007; Ricci, 2014) support the significance of teaching preparation and the strict organization of these practices to ensure learning is effective. It requires that participants are adequately acquainted with the aims of the activity, encompassing its connection to other knowledge already established or in progress within the classroom (Davidson; Passmore; Anderson, 2010).

In addition to its potential for the development of conceptual, procedural, and attitudinal contents, we realize that field classes also provide an opportunity to set the body in motion and allow the outcropping of the senses, which is so essential to the naturalistic tradition. They are sights, sounds, tastes, smells, textures, and displacements that are not typically present in the enclosed spaces of classrooms and laboratories, where instructors and students spend the majority of their time sitting still and moving

around only occasionally. Engaging the body in the movement has the potential to significantly impact the reevaluation and transformation of educational approaches in schools. However, Pegoraro (2003) notes that field classes are frequently developed in formal educational contexts, much like classes in the school environment, with passive, controlled bodies and a predominance of spoken language.

In their study, Mendonça and Neiman (2013) call attention to the excessive emphasis placed on rational aspects during field classes, which hinders the individual's perception, curiosity, and sensory experiences in a particular environment. This diminishes the value of direct contact and renders it unproductive, as the work carried out in the field becomes indistinguishable from that conducted in the classroom.

Other issues associated with these classes include their exceptional nature and inadequate teacher training for their development. Silva (2019) observed that in field classes organized by science teachers, the teacher's silence in these classes predominates, this is even more common in cases where there are guides or monitors in the places. This may indicate a lack of ability to deal with teaching situations in non-formal contexts or point to contemplation and observation as a sufficient way to learn about the environment. For both reasons, this can be problematic, as it can cause these practices to lose their meaning. In addition, lack of coordination between field classes and content teaching, resulting in these activities being perceived as lacking rigor or simply moments of leisure. Additionally, teachers and schools bear the weight of responsibility for student safety, and there is a lack of financial resources for transportation and food expenses for both the school and students (Behrendt; Franklin, 2014; Fernandes, 2007; Nunes; Dourado, 2009; Pegoraro, 2003; Viveiro, 2006).

When observing field class activities in both public and private schools Silva (2019) noted that, when the field class is not configured as a political pedagogical commitment of the school, its insertion is marginal and difficult to complete, overloading the teacher, and may generate disincentives in the face of the difficulties of a solitary work. It is intriguing how educational practices in open and/or natural environments, like field classes, can be incorporated into the school curriculum, as it allows for the development of collaborative strategies that guarantee their efficacy.

The value of field classes, which we discuss, is mainly credited to motivation, engagement, and the various forms of learning opportunistic in direct contact with elements and environments diverse in the classroom, and it is truly remarkable when fully assumed by educational policies and institutions for the teaching of science and biology. The strengths exhibited by these classes provide a compelling rationale for surmounting their challenges and motivate us to strive for a more solid foundation in formal education.

Final considerations: legacy of naturalists to field classes in science and biology education

Thus far, we have discussed how the practical application of the naturalistic tradition in the field has contributed to the development of a paradigm that emphasizes the importance of conducting research in natural settings. This has had significant implications for the field of science. However, as scientific disciplines evolved, such practices were gradually transformed and, in some ways, second concerning the appearance of laboratory biology.

Natural history gave way to biological sciences in the classroom, and with it, naturalistic knowledge and teaching practices were replaced by the contemporary view of biology. Nonetheless, the prevalence of a functional biology perspective did not eliminate field practices and field classes, nor did it leave them unaffected. What we observe is that the historical changes that occurred were crucial for their reinterpretation, meaning that the significance of these practices was revised to align with the demands of the era and circumstances.

Hence, upon careful reconsideration, we revert to our original inquiry: can we plausibly surmise that a heritage of naturalist explorers exists in the present era, of us, esteemed scholars of science and biology? This is a question that we feel comfortable answering in the affirmative, and our rationale for doing so can be found in the process of comparing and contrasting the two methods.

Both scientific field practices and field classes in science and biology education have experienced historical devaluation. This was especially noticeable in the context of field classes, where there was a dearth of funding, investments, teacher training, and public policies that promoted the implementation of such courses of study. If we compare the disparity between instructional materials created for experimental teaching, such as the Nuffield and BSCS curricula, this difference becomes even more pronounced. The field classes exhibit a biological dimension that encompasses human, social, and environmental aspects, which is further enhanced by the pursuit of scientific knowledge with a heightened emphasis on *experimental rigor*.

Another aspect to consider is that the inclusion of field classes in Brazilian elementary education was influenced by educational movements such as anarchist and progressive schools, which were not hegemonic in the national scenario. According to Marandino, Serres, and Ferreira (2009, p. 142, our translation): "[...] when we sought cultural maturation, and the full formation of students, the outputs became not only rich didactic strategies but also representatives of the naturalistic tradition in the curricula of science and biology".

We can gain new insights into the purpose of field studies by looking back at the naturalistic practices that inspired so many people and institutions to embark on journeys into the unknown over a century ago. Indeed, the excursions undertaken by naturalists have the potential to stimulate our contemplation regarding contemporary educational field trips within the realms of curriculum and didactic pedagogical approaches.

The historical and philosophical aspects of these journeys and methodologies have bestowed upon us valuable wisdom for the development of a biology discipline that has profound effects on society and the natural world. Examining this knowledge within its temporal and spatial context undoubtedly enhances comprehension of the essence of science and its contemporary methodologies. Furthermore, this aspect has the potential to inspire novel research that suggests instructional scenarios aimed at highlighting the significance of naturalists' historical contributions to science education.

Moreover, while we may be enticed by an idealized notion of a steadfast discipline captivated by the wonders of the natural world, it is imperative to emphasize the focal point of this heritage: acquiring knowledge in the specific setting and encouraging attention education (Grün, 2008; Ingold, 2015).

In the first case, the location evokes a profound connection to the global community, to the tangible elements and physicality of what we refer to as the natural world and surroundings. We, as human beings, exist within a physical and limited world. Our existence is intertwined and reliant on one another. Field classes provide us with a renewed understanding of our own bodies and the physical nature of the world around us.

In the process of learning to pay attention, we are urged by someone with greater expertise to use all of our senses, not just our vision, which is by far the most valued in educational systems, to perceive what is in front of us. As individuals, we are intricately intertwined with the environment and its various interactions, as we exist as an integral component of it. Education in a specific setting and with focused attention serves to enhance pedagogical practices and deepen the understanding of learning, shifting from solely cognitive and visual aspects to encompassing the physical and other ones imbued with significance.

We cannot deny that this evokes a certain fascination and enchantment for nature, as it appears to have been instilled in naturalist travelers during their expeditions. However, this fascination is inseparable from the study of science itself, including its historical and social contexts, fundamental concepts, methodologies, and ethical principles. Furthermore, it does not sever ties with the imperative need for both individual and collective readjustment in response to the demands posed by nature and socio-environmental obstacles. From our perspective, the classes are holistic, cognitive, affective, and invaluable experiences that require stimulation and execution with clear of objectives.

For the development of these field classes, as well as in the trips of naturalists, there needs to be a collaborative and planning context that makes such classes possible; this entails financial investments, clear purposes, and actions planned and negotiated during and after activities.

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