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ARTICLE / ARTIGO

Citizen Science and Educational Technology for Open Science: An Experience of Co-creating Knowledge with *iNaturalist*

Ciência Cidadã e Tecnologia Educacional para a Ciência Aberta: Uma Experiência de Co-criação de Conhecimento com o *iNaturalist*

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Abstract: This article describes the implementation of a Citizen Science project focused on the collaborative creation of a field guide to the birds of the campus of the Federal University of Santa Catarina (UFSC). The initiative, developed by the Laboratory of Ornithology and Bioacoustics of Santa Catarina (LABOAC/UFSC) in partnership with the Laboratory of Production, Communication and Scientific Memory (CienLAB/UDESC), aimed to promote birdwatching, encourage environmental education, and involve the academic and external community in scientific activities. The methodology included field trips, collection and curation of photographic records, drafting descriptive content, and organizing this data in a digital repository on the iNaturalist platform. The results demonstrated the potential of digital tools to strengthen Citizen Science by enabling broad public participation in the production and validation of scientific knowledge about local birdlife. The experience also revealed challenges, such as information curation and maintaining community engagement. The project reinforced the importance of citizen participation in scientific initiatives, particularly in biodiversity and conservation. The publication of the guide, in both print and digital formats, contributes to valuing the campus as a space for research, recreation, and environmental education, while exemplifying the transformative role of Citizen Science in knowledge construction and in strengthening the relationship between science and society.

Keywords: Open Science, Informal Science Education, University Outreach, Biodiversity, iNaturalist.

Resumo: Este artigo relata a implementação de um projeto de Ciência Cidadã focado na elaboração colaborativa de um guia de campo das aves do campus da Universidade Federal de Santa Catarina (UFSC). A iniciativa, desenvolvida pelo Laboratório de Ornitologia e Bioacústica Catarinense (LABOAC/UFSC) em parceria com o Laboratório de Produção, Comunicação e Memória Científica (CienLAB/UDESC), teve como objetivo promover a observação de aves, fomentar a educação ambiental e envolver a comunidade acadêmica e externa em atividades científicas. A metodologia envolveu saídas de campo, coleta e curadoria de registros fotográficos, elaboração de conteúdo descritivo e a organização desses dados em um repositório digital na plataforma iNaturalist. Os resultados demonstraram o potencial das ferramentas digitais no fortalecimento da Ciência Cidadã, ao permitir a ampla participação do público na produção e validação de conhecimento científico sobre a avifauna local. A experiência também evidenciou desafios como a curadoria das informações e a manutenção do engajamento comunitário. A experiência reforçou a importância da participação cidadã em projetos científicos, especialmente nas áreas de biodiversidade e conservação. A publicação do guia, em formato físico e digital, contribui para a valorização do campus como espaço de pesquisa, lazer e educação ambiental, ao mesmo tempo que exemplifica o papel transformador da Ciência Cidadã na construção do conhecimento e no fortalecimento da relação entre ciência e sociedade.

Palavras-chave: Ciência Aberta, Educação Científica Informal, Extensão Universitária, Biodiversidade, iNaturalist.

1. Introduction

1.1. Citizen Science, Open Science and Environmental Education

Citizen Science can be broadly defined as the active and voluntary participation of non-scientist citizens in the production of scientific knowledge. The term generally refers to the interactions and partnerships between researchers and members of the general public in the collection and analysis of scientific data (Martins & Cabral, 2021). It is closely related to Open Science since it integrates civil society into scientific practice, aligning with democratic principles such as open access to publications, data, and education (Romero, 2017; Silveira & Bisset-Alvarez, 2024). Traditionally, Citizen Science brings citizens closer to public-interest topics, such as environmental and social causes, thus fostering environmental education and awareness of ecological issues (Martins & Cabral, 2021; Santos et al., 2022; Gama & Santos, 2024). This collaborative model has gained prominence in various fields of knowledge, especially those requiring a high volume of field observations, such as studies on the distribution patterns of organisms, becoming an important tool for biodiversity conservation research by expanding research reach (Dickinson et al., 2010; Martins & Cabral, 2021; Santos et al., 2022; Alvim & Silva, 2022).

In the context of digital platforms, Citizen Science and Open Science converge in initiatives that facilitate collaboration between citizens and researchers, creating a more integrated and participatory research environment. This approach broadens access to research stages, involving the public in activities such as data collection, analysis, and description (Gama & Santos, 2024). This type of participation is connected to Responsible Research and Innovation, promoting social inclusion and enriching scientific knowledge (Silva et al., 2023). Species monitoring projects, such as those conducted by natural history museums or birdwatching apps like eBird, exemplify how public participation enriches biological research and promotes environmental conservation (Martins & Cabral, 2021; Santos et al., 2022).

Moreover, Citizen Science strengthens university outreach projects, such as citizen laboratories (e.g., LECA in Brazil), which integrate academics and communities in research on socio-environmental issues (Witt et al., 2023). These initiatives generate scientific data and innovation in a wide range of areas, including agricultural biotechnology (Witt et al., 2023; Silva et al., 2023), fauna monitoring (e.g., aVerAves), and public health (e.g., "Ciência que se respira"), demonstrating how collaboration between citizens and scientists can address complex challenges in biology and health, even in multidisciplinary projects (Romero, 2017).

1.2. Background of the UFSC Campus Bird Field Guide

Birdwatching is one of the main points of contact between society and the natural world, partly because birds are generally conspicuous and charismatic animals. For lay audiences, birdwatching can serve as an introduction to scientific knowledge and environmental education. Promoting this practice within the community is a science communication strategy that contributes to intellectual property development and serves as a tool for socialization, physical exercise, and personal gratification. The Trindade campus of UFSC is highly suitable for this practice due to its diverse environments (forested, shrubby, wetland areas) that attract a significant variety of

species. Socially, the campus also functions as an urban park, a green space frequented daily by thousands of people not only for work and study but also for leisure.

In 2022, a university outreach project was implemented to create a field guide to the campus birds. A field guide is an important species identification tool and also serves as a historical document about local species composition. It traditionally includes occurrence and distribution data, habitat, diet, size, photographs, illustrations, and additional information such as natural history, abundance, migration and seasonality, breeding behaviors, morphology, vocal repertoire descriptions, biological invasion status, and cultural influences (Corbo et al., 2013; Farias et al., 2015; Höfling & Camargo, 1993; Marques et al., 2005; Parrini, 2015; Sick, 1997).

The project prioritized the collective and collaborative process of developing this tool over the final product itself. The social nature of knowledge construction was emphasized throughout all stages, mobilizing professors, students, technical-administrative staff, and various community members interested in birdwatching and wildlife photography.

Originally conceived as a digital book (e-book), the field guide was adapted to a new format, gaining additional functions by integrating with the iNaturalist platform. This adaptation broadened its scope, contributing not only to promoting birdwatching but also to the project's overall goals.

1.3. The iNaturalist Platform

iNaturalist is a widely used Citizen Science platform for recording and sharing biodiversity observations. Since its creation in 2008 at the University of California, Berkeley — and currently in collaboration with the California Academy of Sciences and the National Geographic Society — the platform has facilitated the collection of data on plant, animal, and other organism species, allowing citizens from different parts of the world to contribute directly to scientific projects (Lohan, 2024).

iNaturalist enables users to capture images of organisms in natural and urban environments and submit them for identification, which is carried out both by other community members and by an artificial intelligence system that suggests possible species. This collective process allows the generated data to be used in various biodiversity studies, such as monitoring species distribution or identifying invasive exotic species.

The platform stands out as an important tool for Citizen Science projects, mainly due to its ability to aggregate a large volume of georeferenced observational data. These data, collected by a broad network of participants in different locations and time periods, provide a rich and diverse basis that can be used in academic studies, conservation projects, and public policies aimed at environmental preservation. Moreover, iNaturalist allows for the monitoring of specific projects, offering valuable infrastructure for organizing and tracking data collection initiatives.

Unlike purely academic tools, iNaturalist enables broader and more accessible participation, being used by both researchers and citizens interested in contributing to science. This integration between science and society, facilitated by the use of platforms like this, strengthens engagement in conservation projects and allows for

more comprehensive and diverse data collection, providing access to important research data and encouraging collaboration among different audiences for the protection of biodiversity.

1.4. Objectives

The main objective of this article is to report and analyze the implementation of a Citizen Science project aimed at creating a bird guide for the UFSC campus using the iNaturalist platform. The project seeks not only to develop a reference resource on the local avifauna but also to encourage the active participation of the academic community and the general public in surveying and recording species. Specifically, this article aims to:

a) Describe the methodology used for data collection and integration of community contributions in the development of the bird guide;

b) Assess the impact of citizen participation in expanding knowledge about local biodiversity;

c) Discuss the challenges and opportunities offered by using digital platforms, such as iNaturalist, to engage the community in birdwatching activities;

d) Explore the implications of this type of initiative for environmental education and raising awareness about biodiversity conservation.

Thus, this study seeks to highlight the transformative potential of Citizen Science in the production of scientific knowledge, emphasizing its collaborative and inclusive nature.

2. Method

2.1. Data Collection

The first stage of the UFSC Campus Bird Field Guide consisted of an avifauna survey conducted by the faculty member responsible for the university outreach project and by students from the Biological Sciences program at UFSC, in collaboration with participants from the wider community, through periodic field trips on the university campus. Participation was open to all interested individuals, without any selection process for volunteers. The field trips, popularly known as «passarinhadas» (*birdwalks*), were publicized via email, social media, the university newspaper (Notícias da UFSC, 2023), and booths at science outreach fairs held on campus and other locations on the island, such as the local botanical garden, urban parks, and research and conservation centers open to the public.

Primary data collection methods included transects, route counts, listening points, MacKinnon lists, and lists mediated by the eBird app (eBird, 2025; Ribon, 2010). The systematized list of bird species on the UFSC Trindade campus was compiled from first-hand observations during the field trips, secondary data from academic works on the campus's avifauna, and records from Citizen Science platforms such as WikiAves, eBird, and iNaturalist (Bolduan, 2021; eBird, 2025; Hassemer, 2010; Naka & Rodrigues, 2000; Olsen, 2016; Voitina, 2017; Villanueva & Silva, 1996; WikiAves, 2025). Occasional observations from independent sources were also considered. At the time of

submission of this article, the official list of bird species occurring on the UFSC Trindade campus comprises 153 species.

2.2. Call for Photo Submissions

The project's second stage involved a call for the submission of photographs of the listed species. This stage was widely publicized on social media and around campus, encouraging the community to photograph birds in their daily routines. About 40 photographers, both amateur and professional, contributed images of the species recorded on campus, granting publishing rights for the project.

After the submissions, the LABOAC academic team conducted a review, curation, and editing of the images. This process was coordinated by a university extension scholar to ensure the selected images met certain aesthetic criteria. Image editing, when necessary, was done using the Lightroom application[1]. However, these aesthetic criteria were made flexible to encourage the participation of amateur photographers and community members who may not have professional resources or skills. The team made an effort to ensure that every or nearly every contributing photographer had at least one of their submissions included in the publication.

2.3. Development of the Digital Document (e-book)

The third stage focused on producing the digital document (e-book), involving the curation and editing of images, literature review, writing, and text revision, all carried out collaboratively by the LABOAC academic team. Illustrations and design were developed in partnership with local artists. At the time of this article's submission, this stage is in its final review.

2.4. Inclusion in a Digital Repository

In parallel with the work of LABOAC at UFSC, a partnership was established with CienLab at UDESC, aiming to introduce the UFSC Campus Bird Field Guide into a digital repository. The main goal of this stage was to publish the systematized list of species occurring on the UFSC campus on a citizen science platform open to the public, where information about the species and future observation records made by app users would be centralized through the "Projects" section.

This phase began with a comparative analysis of digital platforms dedicated to fauna cataloguing, with an emphasis on those specializing in birds or focused on general biology. The objective was to identify the most suitable tool for developing an accessible and functional digital guide. Criteria such as usability, customization capabilities, integration with external data, and the availability of essential features — such as draft creation and collaborative information curation — were considered.

Although other platforms were evaluated, iNaturalist was chosen because it is an established tool in the field of Citizen Science, with an infrastructure geared towards collaborative species cataloguing and broad adoption by academic communities. Even though it does not offer a native draft feature — initially considered essential for quality control of records — iNaturalist proved to be the option most compatible with the project's requirements, especially due to its accessibility, user-friendly interface, and

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[1] https://www.adobe.com/es/products/photoshop-lightroom.html

ease of maintenance by biology students and researchers without the need for advanced programming or design skills.
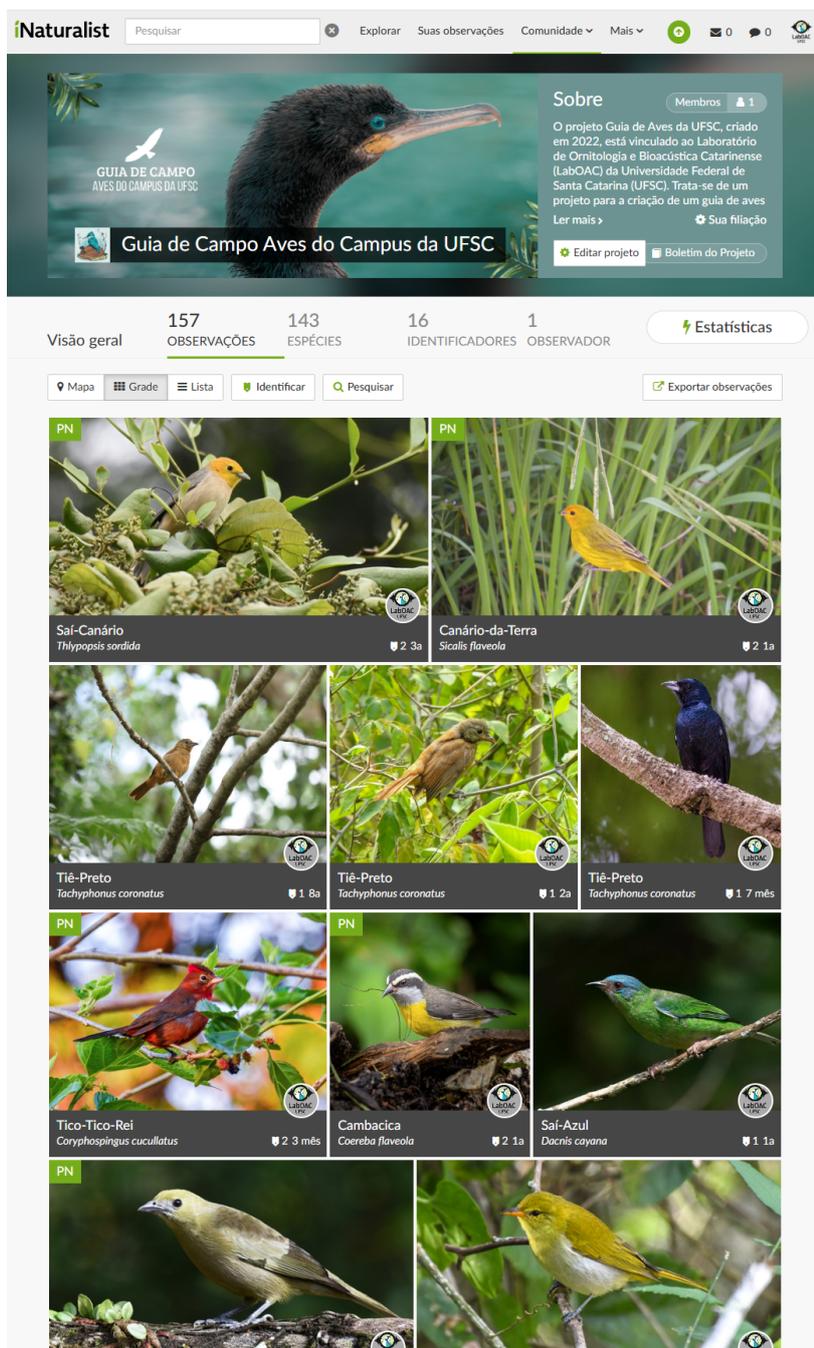

Figure 1. UFSC Campus Bird Field Guide Project on the iNaturalist platform

Once the platform was chosen, an in-depth study of its features was carried out to understand its limits and possibilities in terms of customization and interoperability with external data. The absence of layout customization options was recognized as a limitation but was considered secondary given the robustness of its cataloguing and collaborative engagement functionalities.

Coordination with the UFSC Campus Bird Field Guide project team was maintained to align objectives, goals, and deadlines for the development of the repository. At this point, the inclusion of species vocalizations in the digital repository was defined, incorporating a new element into the project to help app users perform taxonomic identifications based on vocalization references (which is especially relevant when it is not possible to visualize or photograph the species in question). To this end, the Xeno-canto platform (Xeno-canto, 2025), specialized in providing recordings of bird vocalizations from around the world, was adopted.

The data entry process was based on a technical spreadsheet developed from the material provided by LABOAC, which contained detailed information about the bird species recorded on the University campus. The new spreadsheet was adapted to meet iNaturalist's requirements, being structured with specific fields such as: order, family, internal identification number, scientific name of the species, presence of photographic records, image review status, direct links to visual records and vocalizations on Xeno-canto, and a field for notes.

The data compilation followed a rigorous process of individual verification for each species. Vocalizations were selected based on the geographical proximity of the recording to the birds' occurrence on campus, ensuring greater ecological representativeness. The spreadsheet, besides functioning as an intermediate repository, served as a substitute for the platform's draft function, allowing for meticulous review of the information before official publication.

The literature review began in September 2024, with searches conducted in five databases: Scielo (B1), La Referencia (B2), Redalyc (B3), Amelyca (B4), and OpenAlex (B5). The search expression "Ciência cidadã AND Ciência aberta" ("Citizen Science AND Open Science") was used, applying filters to select only open-access articles in Portuguese. All references were managed in Zotero[2], with metadata automatically imported through each database's connector. To facilitate management, an individual folder was created for each source in the reference manager. Additionally, notes were taken on the functionality and filters of each database to optimize future searches.

After the initial import, Zotero's duplicate detection feature was used to identify and remove duplicate records. Next, artificial intelligence was employed to assist in screening the relevance of the articles. For this purpose, a standard prompt was formulated, requesting SciSpace's tool (SciSpace, 2025) to perform a detailed analysis of each article, verifying a) whether it addressed the definition of citizen science and its relationship with open science, b) whether it mentioned projects involving the academic and general community, and c) whether it covered biology-related topics, always requesting that the corresponding excerpts be highlighted in Portuguese. The specific prompt was: "Por favor, analise o conteúdo do artigo na íntegra e verifique se ele apresenta e explica os seguintes temas: O que é ciência cidadã e sua relação com a

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[2] https://www.zotero.org/

ciência aberta; se menciona projetos de ciência cidadã com a comunidade acadêmica e geral; e se menciona algum assunto de biologia. Dê a resposta explicando separadamente cada tema, referenciando local em que é apresentado no artigo. Responda em português."

The AI responses were added as individual notes in each Zotero record, classifying the approach to each theme as significant or superficial. Based on these notes, an auxiliary table was created to guide the final selection of articles, and all exclusions were documented with their respective justifications, ensuring the traceability of the entire process. Initially, the collection resulted in 0 articles for B1, 6 for B2, 92 for B3, 7 for B4, and 147 for B5. After successive refinements and relevance criteria, 10 articles were selected for the theoretical framework that underpins the study on citizen science and the importance of its projects.

The final stage consisted of entering the data into the 'UFSC Campus Bird Field Guide' project created on the iNaturalist platform. This process took place between November 7 and 12, 2024, with support from the CienLab team and volunteers. The presence of metadata previously embedded in the photographs — such as date, author, and scientific name of the species — optimized the repository's data entry, providing greater speed and accuracy to the procedure.

After completion, the content was reviewed by the LABOAC team, which validated the quality and accuracy of the records entered. In a final meeting, the challenges faced during the process were discussed, as well as the solutions found to overcome technical limitations and achieve the project's established goals.

3. Results

The initial data collection actions, carried out during the field phase through mobilizations involving both the internal and external community, resulted in the systematic gathering of photographic and observational records of the birds identified around the campus. The spontaneous participation of students, staff, and other collaborators stood out as a decisive factor for the success of the initiative, directly supporting the activities led by LABOAC, which was responsible for the regular organization of observation activities and the consolidation of the project's database. Short courses and birdwatching events open to the general public were held throughout the project to popularize the practice and disseminate the results achieved.

The quality of the contributions was ensured by a continuous process of monitoring and curation, guaranteeing that the images and records complied with established scientific criteria. Based on the analysis of these contributions, it was possible to organize the information into a structured data table containing detailed descriptions of the recorded species. In this process, the collaboration of ornithology specialists was essential, promoting greater accuracy in species identification and ensuring the technical quality of the systematized information.

Based on the validated data, a digital bird guide model was created, containing descriptive texts, illustrations, and selected photographs, with the aim of making the material accessible and attractive to children and young people. This guide was also made available as a digital repository through the iNaturalist platform, where the

project was officially hosted. The platform enabled the inclusion of multimedia resources, such as photographs and links to vocalizations, as well as the collaborative addition of new observations and continuous monitoring of sightings made on campus. The constant updating of this database on the birds recorded on campus can support academic research in ornithology, urban ecology, and biological conservation. The UFSC campus, with its wooded areas amidst the urban fabric, serves as an ecological corridor between fragmented habitats and has potential to be more widely studied because of this ecological function (Chen et al., 2024).

An interesting development was the completion of an undergraduate thesis by a student from the UFSC Design program in partnership with the LABOAC team (Silva, 2025). This project involved the development of a prototype of a dedicated app for birdwatching on the UFSC campus, aimed at a lay audience and serving as an introduction to this practice. In this way, the UFSC Campus Bird Field Guide took on three forms: an electronic document (e-book), a digital repository (iNaturalist), and an original app.

The development of the app was initially proposed by the Design students themselves, who were interested in the applications of design for environmental education. This was a remarkable outcome, especially because the project's methodology involved field trips for bird observation organized by the external community itself, without any proposal or mediation by LABOAC, demonstrating autonomy in decision-making and in conducting the scientific process, as well as the success of promoting the practice on campus (Silva, 2025).

To make the inclusion of the guide on the iNaturalist platform feasible and to ensure proper data management, CienLAB developed a standardized metadata table covering information on species, photographic and audio records, as well as data related to updates to the digital guide. This initiative facilitated interoperability with the repository and contributed to the digital preservation and open sharing of the data, promoting its use in future research.

4. Conclusions

The development of a bird guide for the UFSC campus through a Citizen Science project demonstrated the transformative potential of collective participation in scientific development. Using the iNaturalist platform as the main collaboration tool, the project promoted the engagement of both the academic and external community in data collection, encouraging birdwatching and involvement with local biodiversity.

The initial results indicate greater environmental awareness, stimulating interest in bird conservation and their habitats. In addition to expanding knowledge of local fauna — since the beginning of the project, at least 10 species not previously recorded on campus have been documented — this is the first initiative to systematically gather and organize photographic records from the area, ensuring accurate documentation of many species that had not been previously recorded.

The project provided a hands-on experience in environmental education, where the public became the main actor in the documentation of scientific data. This

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collaboration between citizens and researchers strengthens the relationship between science and society while facilitating the democratization of knowledge.

However, challenges such as maintaining data quality, ensuring continued community engagement, and curating the collected information require ongoing attention. The experience reported in this article highlights the importance of offering clear guidance and training to participants through direct, in-person interaction during short courses and field outings, ensuring that contributions meet the scientific criteria outlined in fieldwork protocols.

Some methodological limitations are also acknowledged: it was observed that most of the active and regular contributors to the project have academic backgrounds — even if not in ornithology — and are already part of the university environment. In the future, strategies could be developed to increase participation from citizens with different professional paths and socioeconomic profiles, in order to enhance the process of social inclusion. Strategies could also be created to further value the contributions of citizen scientists outside LABOAC and CienLab in creative and logistical decision-making processes.

In summary, the UFSC Campus Bird Field Guide will not only serve as a valuable resource for identifying local bird species but also exemplifies the positive impact that Citizen Science initiatives can have in building a more informed society engaged in environmental preservation. The success of this project may inspire similar future actions, reinforcing the need for new collaborative platforms between scientists and citizens in the pursuit of biodiversity conservation.

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