LUMEN ET VIRTUS
ISSN: 2177-2789

INTERACTIVE TREES: DEVELOPMENT OF EDUCATIONAL SIGNS WITH QR CODES FOR THE ENHANCEMENT OF TREES AND PALM TREES IN THE SÃO FRANCISCO DE ASSIS MUNICIPAL PARK

https://doi.org/10.56238/levv16n46-011

Submitted on: 05/02/2025 **Publication date:** 05/03/2025

Simone Rodrigues Slusarski[1], Karina Dias Espartosa[2] and Robson Ferreira dos Santos[3]

ABSTRACT

The municipality of Assis Chateaubriand (PR) is privileged to house in its urban area the São Francisco de Assis Municipal Park, a forest remnant of the Atlantic Forest Biome, with 64 hectares, which performs important ecological services that contribute to the environmental and life quality of the population. Despite its potential, the Park has historically received little care. Therefore, in response to a request from the Municipal Department of the Environment, this work proceeded to the development of educational signs with QR codes for trees and palm trees of this Conservation Unit, as an initiative of Environmental Education and appreciation of the Park. The methodology included field visits to select the individuals that would receive the plaques, their identification, and research to compose informative texts about each species. The work resulted in the making of 21 plaques for eight species of trees and one of palm trees. Each sign has a short informative text and a QR Code that gives access to an Instagram post with more information about the species. Knowing the properties and environmental services provided by trees and palm trees through the signs, it is expected that the population will have a look of greater appreciation and zeal with the Park and its vegetation.

Keywords: Two-dimensional Barcode. Description of Species. Environmental education. Conservation Unit. Tree and Palm Vegetation.

[1] Doc in Environmental Sciences
Federal Institute of Paraná (IFPR)
Campus Assis Chateaubriand
[2] Master in Ecology
Federal Institute of Paraná (IFPR)
Campus Assis Chateaubriand
[3] Degree in Biological Sciences
Health Department of Assis Chateaubriand – PR

INTRODUCTION

Urban afforestation was a term formerly used to refer to the set of trees linearly planted in urban areas, in a row and with uniform spacing between them (Gonçalves; Paiva, 2004). Technically and currently, urban afforestation is divided into green areas (parks, woods, squares, and gardens) and street afforestation (public roads) (COPEL, 2022). With this scope, urban afforestation is an important element for people's quality of life and well-being, as it performs a series of environmental services. Among them, the following stand out: they help to reduce temperature, as they absorb the sun's rays and refresh the environment by a large amount of water transpired by the leaves; reduce the impact of rainwater and its surface runoff; they provide shade; function as an ecological corridor; they act as a barrier against wind, noise and high light; reduce air pollution; sequester and store carbon; collaborate for a better aesthetic effect; preserve wildlife; they value real estate and cities; provide recreation, physical and mental well-being of the population (Pivetta; Silva Filho, 2002; SÃO PAULO, 2015).

Due to the importance of citizens knowing these benefits to give more value and collaborate with the preservation of urban forestation, several Environmental Education works have been conducted with a focus on this vegetation, to lead the community to develop a feeling of greater affection and commitment to the trees and the city's afforestation. Environmental Education becomes the ideal branch for this purpose, as Environmental Education is understood as the processes through which the individual and the community build social values, knowledge, skills, attitudes, and competencies aimed at the conservation of the environment (BRASIL, 1999), presenting fundamental practices to build a more conscious society, and to form critical and proactive citizens (Fim *et. al.* 2024).

In this context of environmental education, which uses urban afforestation as a means to bring information and awareness to people, the growth in recent years of works that use QR *Code* signs that in addition to identifying the trees bring a series of knowledge, adding the technological aspect to educational, research and extension. Studies report that the population shows interest in knowing the plant species located in the public spaces they frequent and expresses interest in placing identification plates on the plants. Thus, the identification of trees using signs can be a strategy to contribute to the process of Environmental Education (Costa; Saints; Silva, 2020).

Most of these works that use educational signs with *QR Code* have been carried out on trees in schoolyards (eg. Rodrigues; Silva, 2016; Rodrigues *et al.*, 2017; Moura *et al.*, 2019; Ntonio *et al.*, 2023), but some works have taken this resource to urban afforestation outside schoolyards (Rodrigues *et al.*, 2020; Scallop; Spartosa; Slusarski, 2023). The works

mentioned above that use *QR Code* for educational purposes, such as signs, bring it as a method with the potential to make the teaching process more dynamic, capable of offering content in a more interactive way, where people actively participate in the process of searching for information, being able to assimilate knowledge effectively in different locations. The code is pointed out by Vieira and Coutinho (2013) as a method capable of overcoming the barriers of schools and creating and/or enhancing new learning spaces.

Following the example of the studies cited, in Assis Chateaubriand, the work carried out by Vieira, Espartosa, and Slusarski (2023), was the first to proceed with the valorization of urban afforestation through the development of educational signs with *QR Code*, in the identification of trees and palm trees in squares and on the main avenue of the municipality. This work innovated by using the Instagram platform to present additional information about plant individuals made available through the *QR Code*. Then, in the same municipality, Antonio *et al.* (2023) carried out similar work with the afforestation of the Federal Institute of Paraná (IFPR) *Assis* Chateaubriand Campus. This initiative provided improvements in the size, *layout,* and material of the signs from what was done by Vieira, Espartosa, and Slusarski (2023) in the squares and main avenues, making them more attractive and robust.

The contemporaneity and usefulness of the signs of these two works included trees from Assis Chateaubriand and the quality of the information they keep in their *QR Codes*, even caught the attention of the municipality's Environment Directorate, which contacted the teams involved in these projects, offering support for similar signs to be developed for trees in the São Francisco de Assis Municipal Park (PMSFA). With an area of 65.04 hectares, the PMSFA is located within the urban region of Assis Chateaubriand and, therefore, contributes greatly to the microclimate of this locality (Augusto, 2011).

In addition to covering extension projects that led different audiences in monitored visits and workshops (Espartosa; Oshika; Joaquim, 2020), the PMSFA has also been contemplated by academic works. Among them, are the work of Augusto (2011), who evaluated the aspects of conservation/degradation and the forms of use of the Park, and that of Rielle (2019), who intended to propose a better use of the Park's area, stand out. Both works, in their surveys and analyses, mention the state of abandonment of the Park's structures, lack of security, and the scarcity of investments by the management, despite the potential that this area has for leisure and environmental education. These works propose and encourage educational actions to add value to the Park.

Therefore, in response to the request of the Municipal Department of the Environment of Assis Chateaubriand and aiming to add appreciation and environmental education to the PMSFA with the offer of information about its trees and palm trees, this

work aimed at the selection and identification of plant species in the Park and the development of educational signs with *QR Code.* With this, it is intended to stimulate the interest of visitors in the conservation of the Park and its vegetation by recognizing its importance to the environmental balance and the quality of human life, in addition to providing an educational instrument that can be part of the itineraries of guided tours in the Park.

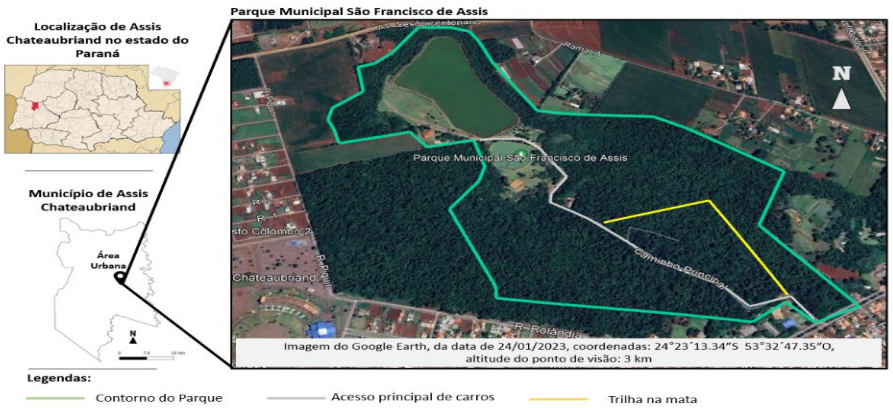
MATERIAL AND METHODS

This is an extensionist and action research work (Martins, 2015), since it takes students to the forefront of research on the selected trees and palm trees and the composition of the texts presented by the signs, resulting in a product that is available to society as a form of Environmental Education. It also has an interdisciplinary character, as it covers different areas of knowledge, such as botany, environmental education, graphic design, textual production, and computer science; and interinstitutional character, since it was carried out with the contribution of different entities.

CHARACTERIZATION OF THE STUDY AREA

The São Francisco de Assis Municipal Park (PMSFA) has an area of 65.04 hectares and constitutes a forest remnant inserted in the Atlantic Forest Biome and the phytoecological region of the Semideciduous State Forest. Located near the commercial center of the city, it was donated to the municipality by the former colonizing company of the region (Colonizadora Norte do Paraná) as payment for back taxes, which was made possible by Municipal Law No. 412 of 1978 (Assis Chateaubriand, 1978). Historically known as Horto Florestal, this green area became a Conservation Unit only in 2001 thanks to Municipal Law 1658 (Assis Chateaubriand, 2001) (Figure 1).

Figure 1 – Location of the São Francisco de Assis Municipal Park, in the municipality of Assis Chateaubriand, Paraná.



Source: prepared by the authors.

The PMSFA is composed of lakes, streams, springs, and in its largest scope, vegetated areas that are home to several species of wild fauna. The Park also has open areas with leisure structures (kiosks, *playground*, sand court, and walking track), which makes its visitation daily for the citizens, a habit that intensifies on weekends (Augusto, 2011; Rielle, 2019).

SELECTION OF PLANT INDIVIDUALS TO BE CONTEMPLATED WITH THE PLATES AND THEIR IDENTIFICATION

In May 2022, some routes were carried out in the Park to reconnoiter the area and select the plant specimens with the potential to be contemplated by the signs. Individuals of the most representative and attractive size and appearance were selected who could naturally arouse the attention and curiosity of the public. It was also a selection criterion that the specimen be located in a location of easy and greater access to the public that frequents the Park, so that this public can view the sign properly and be able to reach them without hindrance, thus being able to scan the *QR Codes* available on them. For this reason, the selected trees and palm trees are located on the gravel road that, from the entrance to the Park, gives access to its leisure area; in open areas with leisure structures; and along the 800m trail that crosses one of the forested portions of the PMSFA, where monitored visits take place (Figure 1).

As a specimen was selected, written and photographic records of its characteristics were made, botanical samples were collected and the individual was marked with red tape. The botanical samples collected were herborized according to the usual techniques (Fidalgo; Bononi, 1989) for subsequent identification that was carried out through analytical keys, available in Flora do Brasil (Flora and Funga do Brasil, 2023) and specialized literature (Souza; Lorenzi, 2012). Comparisons of exsiccates and other visual information were also carried out with digital images from the Tropicos *website database* (Tropicos, 2022). The writing of the scientific names, the abbreviation of the authors' names, and the geographical distribution of the species followed the List of Species of the Flora of Brazil (Flora e Funga do Brasil, 2023).

SEARCHES FOR INFORMATION, AND DEVELOPMENT OF INFORMATION TEXTS VOS ON THE SELECTED TREES AND PALMS

The research to collect information on the selected trees and palm trees was carried out strictly in specialized literature (e.g. Lorenzi, 2014; Lorenzi; L; Bacher, 2015; Lorenzi; Bacher; Torres, 2018) and on websites with technical reliability about Brazilian plant

species, Flora do Brasil (Flora e Funga do Brasil, 2023) and the Brazilian Agricultural Research Corporation - EMBRAPA (EMBRAPA 2022).

For each identified individual, information was sought such as characteristics considered interesting to the public, such as flowering, fruiting, leaf and crown shape, height, longevity, human uses, and main ecological services. This information composed a database for each species and from it, the texts about each tree were written.

MAKING AND INSTALLATION OF THE PLATES

From other published works similar to this one, the choice of the type of material of the plaque and its size was made, according to criteria that involved costs and durability, given aspects of the Park as an area that would receive this material. There was a composition of the *layout* of the sign and the additional information that would be offered through the *QR Codes*. In the *layout* of the signs, the decisions were related to the positioning of the code, the logos of the supporting and developing entities, the introductory text about the species, and the title with the popular and scientific name of the tree and palm tree; to draw people's attention, in addition to encouraging them to scan the *QR Code* to learn more about the subject. To generate the *QR Codes*, the *QR Code Monkey website*[4] was used.

RESULTS AND DISCUSSIONS

A total of 21 plant individuals belonging to nine species, covering seven families, were selected to receive the plates (Table 1). Among these selected trees and palms, two are exotic: the mango tree (Mangifera indica L.) and the imperial palm (Roystonea oleracea (Jacq.) O.F. Cook). It was decided to also identify these exotic species so that, in the case of the mango tree, the visitor could verify the changes in the appearance of a known tree, when it is in the forest. The imperial palm tree, on the other hand, is an abundant species in the afforestation of the central median of the main avenues of the municipality, having also been planted on the main road of the Park. It was decided to place a plaque on this species for the visitor to learn a little more about the interesting history of the arrival of the imperial palm tree in Brazil and the probable reasons for its distribution and presence in the municipality, linked to its aspect of nobility, refinement and grandeur (Lorenzi et al., 2004; Scallop; Spartosa; Slusarski, 2023).

[4] https://www.qrcode-monkey.com/pt/

Table 1 - List of species of plant individuals from the PMSFA that were selected to receive the identification plates. The table also shows the number of individuals selected from each species and the total number of plates produced.

Popular name	Scientific name	Family	Number of Individuals Selected/ Number of Plates
Guapuruvu	*Schizolobium parahyba* (Vell.) Blake var. *Parahyba*	Fabaceae	1
Hose	*Mangifera indica* L.	Anacardiaceae	2
Tapiá	*Alchornea triplinervia* (Spreng.) Müll.Arg.	Euphorbiaceae	3
Rosemary-de-Campinas	*Holocalyx balansae* Micheli	Fabaceae	2
Milk Guatambu	*Chrysophyllum gonocarpum* (Mart. & Eichler ex Miq.) Engl.	Sapotaceae	6
Peroba-rosa	*Aspidosperma polyneuron* Müll.Arg.	Apocynaceae	1
Yellow trumpet	*Handroanthus chrysotrichus* (Mart. ex DC.) Mattos	Bignoniaceae	1
Ipê-roxo	*Handroanthus heptaphyllus* (Vell.) Mattos	Bignoniaceae	2
Imperial palm	*Roystonea oleracea* (Jacq.) O.F.Cook	Arecaceae	3
	Total Plates		**21**

Source: the authors

STUDY OF THE POSSIBILITIES OF THE *QR CODE* AND SELECTION OF FORMS OF PRESENTATIONTATION OF INFORMATION

Throughout this work, it was evaluated whether the information to be displayed by the *QR Code* would use only the space for textual content available within this code – in this case, this content is presented as soon as the code is scanned; or inserted in the *QR Code* a link that directs to an online platform that houses the content. The first option does not require that the person who will scan the code be connected to the internet, and at first this was the first option of this team, as the PMSFA does not offer *free wi-fi*, and until recently few places in the Park had a cell phone signal that allowed the visitor to access their mobile data. However, the free version of the *QR Code* (which is the one used in this work) has a limitation on the number of characters that can be presented within the code and does not have text formatting options or the insertion of images. Thus, the information presented should be short, without highlights, and without the possibility of presenting an illustrative figure of the tree or palm tree, as chosen by Rodrigues and Silva (2016) and Rodrigues *et al.* (2017) in their work with tree identification plates with *QR Code*.

However, when reconnoitering the area and selecting plant individuals, the team found that currently in the vicinity of all selected specimens, there was good cellular signal and access to mobile data. Tests were carried out and it was proven that the visitor would be able to scan the *QR Code* and, through their mobile data, access the information available through a link. Thus, it was decided to deliver the information through a link given the possibility that this strategy offers, of presenting a greater amount of information, whether written or in the form of an image, and with a greater possibility of elaborating a layout for the information.

Among the works similar to this one that chose to present information about plant species through an online platform, some chose to house images and information about trees on the website of the contemplated institution, such as the work carried out in the green area of UNESP Campus Botucatu (Costa; Rocha, 2017). Similarly, Moura *et al.* (2019), Grala *et al.* (2022) and Vitória *et al.* (2022) also housed information about the trees that received plaques on websites, but which in this case were developed for the project, with Vitória *et al.* (2022) developed the page using the *Google Sites* platform. The works of Antonio *et al.* (2023) and Vieira, Espartosa, and Slusarski (2023), chose to house the extra information about the trees in their profile for the project on Instagram. All these authors opted for the *online platform* because the location of the signs had a *Wi-Fi* network or a telephone signal that could allow the visitor to connect to the internet.

An alternative, which allows presenting, even without internet access, formatted information, with images and without character limits, is the development of an application that houses information about trees with signs, and whose *QR Codes* on the sign direct the visitor to the interface of the application referring to a certain species; an alternative adopted by Rocha, Cruz e Leão (2015), Abreu, Souza e Lacerda (2017) and Costa e Rocha (2017). However, it should be noted that this option depends on the visitor having the application installed on their mobile device.

The social media application Instagram is currently very attractive, it allows your posts to be presented with an attractive, relaxed, and very colorful layout, in addition to making it possible to measure the number of views of the posts, helping to understand the reach of this type of strategy in the future. In addition, each Instagram post has its *URL* (*Uniform Resource Locator*), whose link can then be housed in the *QR Code* of a sign, which when read would direct the person to this particular post, even if this person does not have an account on this social network. Therefore, dispensing with the work of creating a website or an application that houses information about the trees and palm trees that receive plaques.

Based on these advantages and since the present work is inserted in the scope of the same municipality and the same research project as the work of Antonio *et al.* (2023) and Vieira, Espartosa, and Slusarski (2023), it was decided to continue the use not only of the Instagram platform but also the use of the same profile that these works used, the "@arvoresinterativas". This contributes to this profile becoming more active (something relevant in this social network) and rich in information, even forming a digital catalog of plant individuals in the municipality of Assis Chateaubriand (PR). With the links that Instagram itself offers and that direct to each post, QR Codes were generated, generating free, non-editable codes.

DEVELOPMENT OF THE INFORMATIVE TEXT ABOUT THE TREES AND THE *LAYOUT* OF INSTAGRAM POSTS

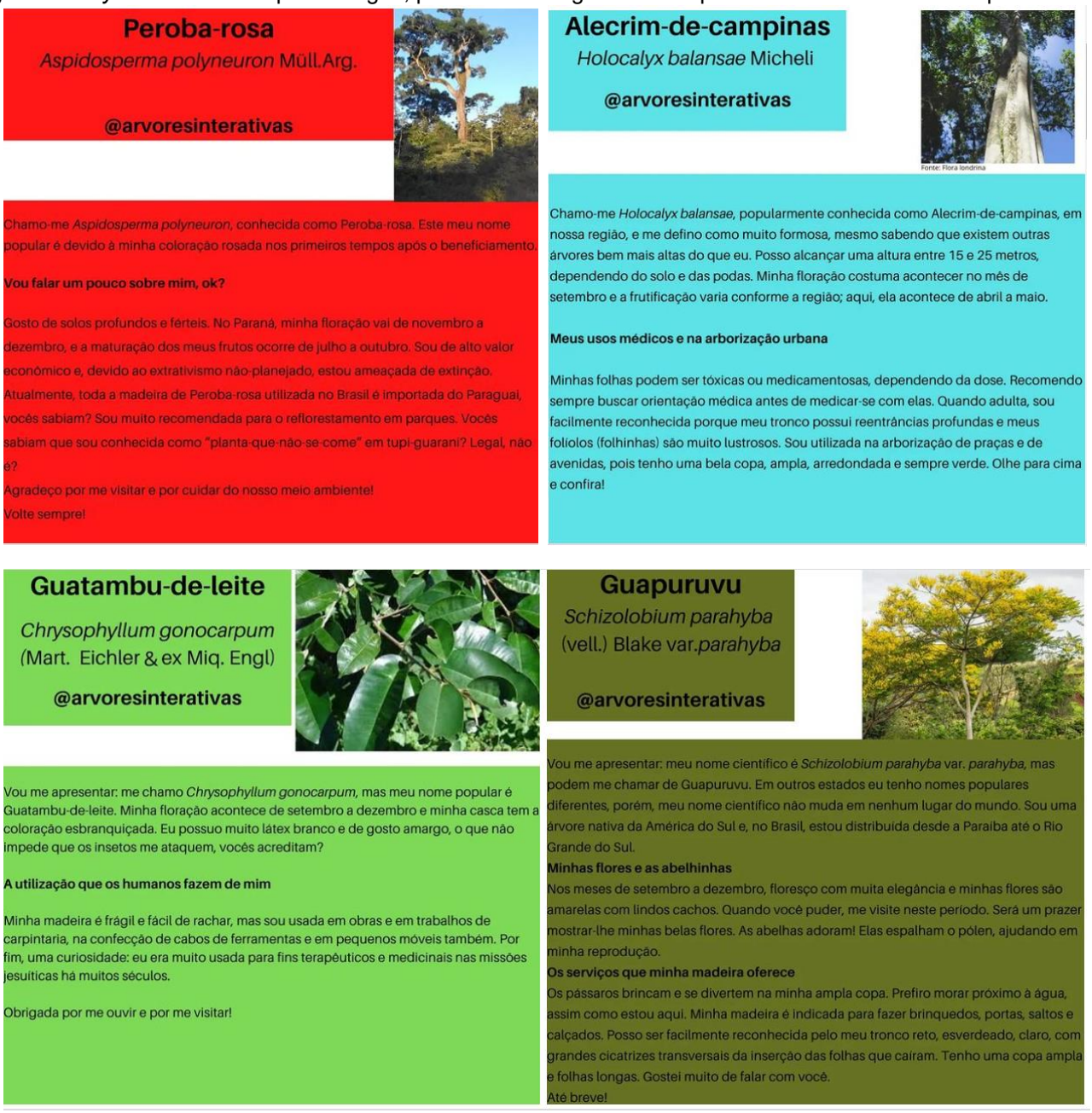
The information contained in tree identification plates is traditionally arranged in items and with more technical language, even in more current plates that have *QR Codes* (e.g. Rock; Cross; Leão, 2015; Rodrigues; Silva, 2016; Duque *et al.* 2019). However, some works innovated in this aspect, using information about the tree in the elaboration of colloquial texts and the form of dialogue. These texts give the impression that the tree itself tells its predicates in a relaxed conversation with the visitor, configuring a prosopopeia. Examples of works that proceeded with this strategy are: the tree plates developed by the city of João Pessoa (PB) in the description of its trees of the City Trees Project (City Hall of João Pessoa, 2021); descriptive plaques of trees located in squares in Bagé (RS) (Grala *et al.* 2018, 2022) and the tree plates developed by Antonio *et al.* 2023 and Vieira, Espartosa and Slusarski (2023), which were based on the two works first cited.

The team of researchers of this work chose to follow this method, writing texts in colloquial language and the first person, to uncomplicate the information that is being transmitted and bring PMSFA visitors closer to plant individuals while maintaining the technical rigor of the information. This strategy becomes of special importance in Park signs because most of the visitors are children and in this format even they will be able to understand the information when read by their parents. All the texts developed in the present work were grammatically reviewed by a professional graduate in letters, and part of them can be seen in Figures 2 and 3.

The posts for the Instagram app were made using the Canva app, which is a free *online* graphic *design* tool. These posts, which present the dimensions 1080px x 1080px, illustrate the *layout* developed for this work, which has a representative image of the plant

individual, available on the internet with a license for use, and the text containing some important information and particularities of that plant individual (Figure 2).

Figure 2 - *Layout* of the descriptive images, posted on Instagram - example for four of the identified species



Source: the authors

DETAILS ABOUT THE PLATES

After testing the appearance of different dimensions of plates on the trees and palm trees of the Park, it was decided to make them the size of 27 x 21 cm (a size slightly smaller than an A4 sheet), because it ensures good visibility while not being very large, they do not cause visual pollution. It is important to emphasize that although this work is part of the same research project that developed signs for other locations in the municipality of Assis Chateaubriand, the choice of the size of the sign in each location was different.

The signs for trees and palm trees on avenues and squares in the municipality, which were the first to be made, were 15 x 15 cm in size (Vieira; Spartosa; Slusarski, 2023), but over time the team of researchers found that a larger size would be more appropriate to give visibility to the information. Therefore, for the signs installed in the afforestation of the IFPR *Campus* Assis Chateaubriand, the size 25 x 18 cm was chosen, in an open environment, with spacing between plant individuals, but where the signs would be visually close to each other, it seemed more appropriate that the information be visible without the signs causing visual pollution (Antonio *et al.* 2023). For the Park, however, the size of the signs could be even larger, as the place has dense vegetation, where small signs would have little prominence. This and other details provided below in this item are intended to assist in the decision-making of researchers who will develop similar work in the future.

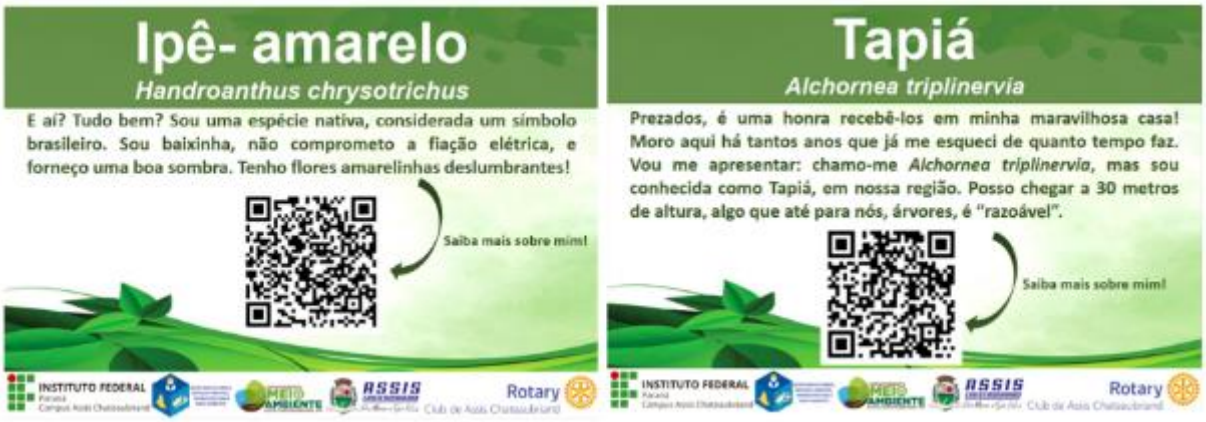
The plates can be made in different materials and sizes, which will result in different costs, robustness, and durability. Some studies use chemograved metal plates (Grala *et al.* 2022), 2mm PVC boards (Vitória *et al.* 2022; Scallop; Spartosa; Slusarski, 2023), or plates made of plasticized bond paper (Rodrigues; Silva, 2016). Most authors did not report information about the strength of the chosen material, except Vieira, Espartosa, and Slusarski (2023), in which the researchers opted for the use of 2mm PVC boards with vinyl adhesive, and found that in a short time (and even during installation) this material proved to be fragile for this purpose.

Therefore, following the example of the durability verified in some existing notice boards in the PMSFA, this work chose to make them in 3mm thick composite aluminum (ACM), with the image printed on vinyl adhesive, which withstands well exposure to time. However, 3mm ACM boards have a higher cost than 2mm PVC boards. As consulted in a local printer, a 3mm ACM board of A4 size costs about R$25.00 per unit, while a 2mm PVC one costs about R$15.00 (September 2022 quotes).

About content, the signs feature the popular name highlighted, followed by the scientific name, a short informative text (with ecological, phenological, and human use information), and the *QR Code*, which gives access to the *Instagram post* with more information about the species (Figure 2). They also present the logos of all partner institutions in the realization of this project: that of the IFPR *Campus* Assis Chateaubriand, whose team of servers and students was in charge of the making of all the content and *design* of the signs; and the logos of the Rotary Club of Assis Chateaubriand, the Municipality of Assis Chateaubriand, as well as the logos of its Secretariat of Works, Urban Services, Infrastructure and Environment, and Department of Environment. These last four institutions paid for the making of the signs, the wooden rods, and their installation. To

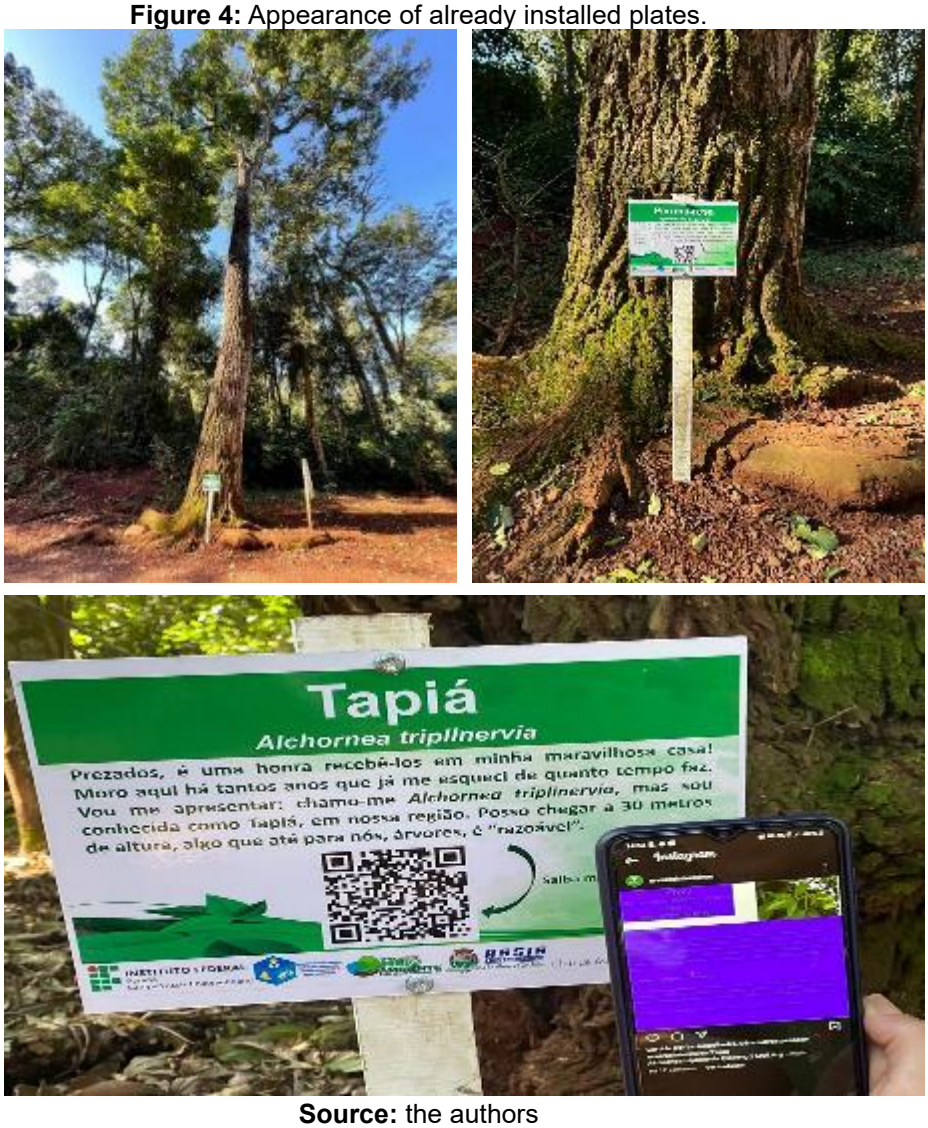
maintain a standard, the signs followed the same background *layout* that existed in the signage and information boards already available in the Park. The tree identification plates were installed in June 2023, on a wooden pole at a height of 1.3 m, in front of the corresponding tree or palm tree (Figures 3 and 4).

Figure 3: *Layout* of two signs (the *QR Code* of the image can be scanned).



Source: the authors

Figure 4: Appearance of already installed plates.



Source: the authors

Following the example of Grala *et al.* (2022), after the installation of the signs in public squares in Bagé (RS) held a launch event in the squares with the support of the city hall and the presence of the community, the present work also carried out dissemination actions, which in this case were the publication in local newspapers, on the Instagram of the Municipal Department of the Environment, and the institutional website of the IFPR *Campus* Assis Chateaubriand. These dissemination actions are important to give visibility and value to the plaques, inviting the community to benefit from them to their appreciation.

CURRENT CONDITIONS OF THE PLATES

As it is common to see with traffic signs and various warnings, vandalization or deterioration of tree identification plates also occurs, as reported by Grala *et al.* (2022), whose plaques were placed in public squares, and by Vieira, Espartosa, and Slusarski (2023) whose plaques were also placed in squares and other public places. Therefore, the plates installed in the PMSFA have been monitored to verify their durability and the damage they may suffer.

Between the time of installation of the signs (June 2023) and the submission of this work for publication (May 2024), a period that adds up to 11 months, five of the 21 signs are no longer in their places and were not found in the Park, which may be a sign of vandalization. The only employee responsible for the maintenance of the Park and the staff of the Department of the Environment (whose office is located inside the Park) was consulted about the whereabouts of these signs, but none of those consulted could say what had happened to these signs.

The employee responsible for maintenance reported that on some occasions he put back in place signs that were found bent or fallen next to the tree. In the same sense, the project team also replaced plates found crooked or fallen during the monitoring periods. In addition, two signs were dirty with dirt and with partially torn adhesives, and from the evidence it was possible to prove that this was done by the capuchin monkeys (*Sapajus* sp.) residing in the Park.

CONCLUSIONS

Considering the visual aspect and the informative compilation available on the signs produced and installed, it is considered that they represent an advance of the municipality towards greater attention, care, and appreciation of this important green and regional leisure area that represents the São Francisco de Assis Municipal Park. It is expected that this initiative, which innovates by bringing information also in a technological way, and through a

very popular platform today, Instagram, will also engage visitors in a greater appreciation and care for the Park and its vegetation.

To support future researchers who aim to develop educational signs for trees, from this work and other similar ones carried out in Assis Chateaubriand, it is intended to continue with the monitoring of the signs for the future production of an article that presents the advantages and difficulties of this type of initiative, the durability and costs of the boards according to the material used, and occurrence of losses possibly related to vandalization and other occurrences. The data that the team of this study missed was reported in the available literature.

REFERENCES

1. ABREU, J.; SOUZA, J. W.; LACERDA M. A mobile application for education. *In:* Brazilian Symposium on Informatics in Education, 28. 2017. *Anais digitais do [...].* Available at: http://milanesa.ime.usp.br/rbie/index.php/sbie/issue/view/171. Accessed on: 13 Apr. 2023.

2. ANTONIO, M. de O.; BARROS, P. M. V.; SLUSARSKI, S. R.; ESPARTOSA, K. D. Interactive urban afforestation: development of signs with *QR coded* for didactic presentation of plant individuals in a schoolyard. *Revista Foco*, *16*(12), e3793. https://doi.org/10.54751/revistafoco.v16n12-156, 2023.

3. ASSIS CHATEAUBRIAND, PR. Law No. 412. of September 26, 1978. Authorizes the Executive Branch to acquire land areas, through exemption, compensation, and/or tax transaction, establishing other provisions. *Approved by the City Council***.** Assis Chateaubriand-PR.

4. ASSIS CHATEAUBRIAND, PR. Law No. 1658 of October 29, 2001. Provides for the creation of the São Francisco de Assis Municipal Park and makes other provisions. *Published in the newspaper O Regional,* Assis Chateaubriand-Pr, n.800. of October 31, 2001.

5. AUGUSTO, J. R. *Evaluation of aspects of conservation/degradation and forms of use of the São Francisco de Assis Municipal Park, in the municipality of Assis Chateaubriand – PR.* 2011. 118 p. Master's thesis. State University of Maringá, 2011.

6. BRAZIL. Law No. 9,795, of April 27, 1999. Provides for environmental education, institutes the National Policy for Environmental Education, and provides for other provisions. *Official Gazette [of] the Federative Republic of Brazil*, Brasília, DF, n. 79, Section 1, p.1-3, 28 Apr. 1999.

7. COPEL, 2022. Companhia Paranaense de Energia. *Copel and the afforestation of public roads, how to reconcile afforestation and electrical distribution networks.* Available at http://www.copel.com/hpcopel/guia_arb/a_arborizacao_urbana.html. Accessed on 04/12/2022.

8. COSTA, P. B.; ROCHA, L. A. G. Translation as a knowledge diffuser: experience with an environmental education application on a platform. *In:* Symposium on Hypertext and Educational Technologies, *7, 2017,* Federal University of Pernambuco. *Annals of [...].* Available at: https://sitecesad.ufs.br/conteudo/17982-vi-edi--o-do-simp-sio-hipertex. Accessed on: 27 Feb. 2024.

9. COSTA, R. R.; SANTOS, M. G. S. S.; SILVA, R.N. Analysis of the environmental perception of the visitors of the Dom Constantino Luers green area, in the municipality of Arapiraca-AL. *REVSBAU,* Curitiba – PR, v. 15, n. 1, p. 50-65, 2020.

10. DUQUE, C. A.; CARBO, L.; LUCENA, I. C.; AGUIAR, C. K.; FERNANDES, P. M. B. Science teaching by research and the use of the rapid response code (*QR code*) in an environmental recovery area. *Journal of Education, Sciences and Mathematics*, v.9, n.2, p. 156-172, ISSN 2238-2380, May/Aug 2019.

11. EMBRAPA - Brazilian Agricultural Research Corporation. *Embrapa Information Agency.* Available at:

https://ainfo.cnptia.embrapa.br/digital/bitstream/CNPF-2009-09/41468/1/circ-tec97.pdf . Accessed on: 13 APR. 2022

12. ESPARTOSA, K. D.; OSHIKA, M. T. S.; JOAQUIM, C. M. B. Experience of environmental education in a municipal park with children and adolescents in social vulnerability. *REVBEA*, v. 15(2). p. 148-151. 2020. paper presented at the PARANAENSE MEETING OF ENVIRONMENTAL EDUCATION - EPEA, 17, 2020, Londrina - PR.

13. FIDALGO, O.; BONONI, V. L. R. (coords.). *Techniques for collecting, preserving, and herborizing botanical material.* São Paulo, Instituto de Botânica, 1989.

14. FIM, L. C. R.; ZAGOTO, M. P.; DE OLIVEIRA, W. B.; SCHIAVO, M.; VETTORAZZI, M. R. G.. Sustainability and citizenship: environmental education as a pillar of development. **LUMEN AND VIRTUS**, *[S. l.]*, v. 43, p. 8288–8306, 2024. DOI: 10.56238/levv15n43-050 . Available at: https://periodicos.newsciencepubl.com/LEV/article/view/2222. Accessed on: 26 Feb. 2025.

15. FLORA AND FUNGA OF BRAZIL. *Botanical Garden of Rio de Janeiro.* Available at: http://floradobrasil.jbrj.gov.br/. Accessed on: 26 Nov. 2023.

16. GONÇALVES, W.; PAIVA, H. N. *Trees for the urban environment.* Viçosa, MG: Aprenda Fácil, 2004. 243 p.

17. GRALA, K.; ROSSETO, V.; RODRIGUES, R. O.; MARTINS, M. M.; SAMPAIO, N. V.; SAMPAIO, T. M. G. The use of the *QR Code* for inclusive management in the urban afforestation of Bagé, RS. *Interactions*, Campo Grande, MS, v. 23, n. 3, p. 759-775, jul./set. 2022.

18. GRALA, K.; RODRIGUES, R. O.; ROSSETO, V.; CAVALCANTI, G. G.; LEITE, E. G. Urban afforestation - an exercise of citizenship and socio-environmental sustainability. In: University Extension Seminar of the Southern Region, 35, 2018. *Annals of [...].* Available at: https://www.ufsm.br/pro-reitorias/pre/2018/03/06/anais-do-35-seurs. Accessed on: 26 Nov. 2023.

19. LORENZI, H. *Brazilian trees: a* manual for the identification and cultivation of native tree plants in Brazil. V. 1, 2 and 3, 6th ed. São Paulo: Instituto Plantarum de Estudo da Flora, 2014.

20. LORENZI, H.; BACHER, L. B.; TORRES, M. A. V. *Exotic Trees and Trees in Brazil:* Woods, Ornamentals and Aromatics. Nova Odessa: Plantarum Institute for Flora Studies, 2018.

21. LORENZI, H.; LACERDA, M. T. C.; BACHER, L. B. *Native and Exotic Fruits of Brazil:* (Fresh consumption). São Paulo: Instituto Plantarum de Estudos da Flora, 2015. 768p.

22. LORENZI, H.; SOUZA, H. M.; COSTA, J. T. M.; CERQUEIRA, L. S. C.; FERREIRA, E. *Brazilian and exotic palm trees cultivated.* Nova Odessa: Instituto Plantarum, 2004.

23. MARTINS, R. X. (ed.). *Research methodology: practical guide with emphasis on Environmental Education.* Lavras: UFLA, 2015. 150 p.

24. MOURA, L. R.; MATIAS F. C.; SANTANA, I. C. H.; SOUSA F. J. S. Digitized plants: the use of QRcode as a tool for teaching botany carried out in the discipline of STS (science, technology and society). *In fashion.* International Meeting of Young Investigators, 4, 2019, UNEB - State University of Bahia/ BA. *Electronic Annals.* Available at: https://editorarealize.com.br/editora/anais/join/2019/TRABALHO_EV124_MD1_SA6_ID270_14072019205323.pdf. Accessed on: June 11, 2023.

25. PIVETTA, K. F. L.; SILVA FILHO, D. F. *Urban Afforestation.* UNESP Academic Bulletin, Jaboticabal, SP, 2002.

26. CITY HALL OF JOÃO PESSOA. City Trees Program. João Pessoa, 2021. Available in: https://www.joaopessoa.pb.gov.br/programas-and-projects/city trees--/Brazil nut tree/. Accessed on Nov. 15. 2021.

27. RIELLE, M. C. *Requalification of the São Francisco de Assis Municipal Park.* 2019. 65 p. Course Completion Papers. Universidade Paranaense (UNIPAR), Toledo campus, 2019.

28. ROCHA, L. A. G.; CRUZ, F. M.; LEÃO, A. L. Application for Environmental Education. *Electronic journal Fórum Ambiental da Alta Paulista*, Portugal, v. 11, n. 4, pp. 261-273, 2015.

29. RODRIGUES, R. O.; LEITE, E. G.; CAVALCANTI, G. G.; GRALA, K.; SAMPAIO, N. V.; ROSSETO, V. Urban afforestation program: Application of the *QR Code* in the identification of trees in the schoolyard. *In:* SALÃO INTERNACIONAL DE ENSINO, PESQUISA E EXTENSÃO - SIEPE, 9, 2017, Santana do Livramento. *Annals [...]*element.

30. RODRIGUES, R.; SANTOS, M. D.; CHAVES, S. A. B.; SAMPAIO, T. M.; SAMPAIO, N. V.; GRALA, K Urban afforestation program: Use of QR *Code* in tree knowledge. In: *International Salon of Teaching, Research, and Extension of UNIPAMPA Extension Salon*, 8, 2020. *Annals [...]*element.

31. RODRIGUES, R. S.; SILVA, G. R. R. Use of the *QR Code* as a management tool in the identification of tree species on the *IFPA-Bragança* campus.*In: Brazilian Congress of Environmental Management, 7, 2016,* Campina Grande/PB. *Annals [...]*element.

32. SÃO PAULO, São Paulo City Hall, Municipal Secretariat of Green and Environment. *Technical Manual of Urban Forestry.* São Paulo-SP, 2015. Available at https://www.prefeitura.sp.gov.br/cidade/secretarias/upload/meio_ambiente/MARBOURB.pdf. Accessed on: 10 Aug. 2021.

33. SOUZA, V.C.; LORENZI, H. *Systematic Botany:* an illustrated guide for the identification of native and exotic phanerogamous families in Brazil, based on APG III. 3rd ed. Nova Odessa: Instituto Plantarum, 2012.

34. TROPICS. *Missouri Botanical Garden.* Available at: <http://www.tropicos.org>. Accessed on: 12 Apr. 2022.

35. VIEIRA L. S., COUTINHO, C. P. Mobile learning: envisioning the potential of QR codes in education. International Conference on ICT in Education. *In:* Challenges 2013: Learning anytime anywhere, 2013. University of Minho, ICT Competence Center of the Institute of Education, Braga, Portugal. *Electronic annals.* Available at:

https://repositorium.sdum.uminho.pt/bitstream/1822/25450/1/Liliana_challenges2013.pdf. Accessed on: 16 Jul. 2021.

36. VIEIRA, K. G. C.; ESPARTOSA, K. D.; SLUSARSKI, S. R. Interactive urban afforestation: Implementation of QR *Code signs* for the description of plant individuals. *In*: Seven Publications (eds.). *Technology and Innovation in Agricultural and Biological Sciences:* advances for a current society. Seven Editora, 2023. Electronic book. DOI: https://doi.org/10.56238/tecnolocienagrariabiosoci-006. Available at: https://sevenpublicacoes.com.br/index.php/editora/article/view/1770. Accessed on: 24 Aug. 2023.

37. VITÓRIA, N. J. V.; RAMIREZ, G. L.; SILVA, M. J. B.; PEREIRA, N. L.; BARROS, L. G. P.; MAGISTRALI, P. L.; NASCIMENTO, J. F. What tree is this? Use of *QR Code* in the teaching of botany. *Research, Society and Development*, v. 11, n. 16, e15111637681, 2022.