Monumental Trees: Guided Walks as an Educational Science Awareness Experience

ABSTRACT

To reduce "plant blindness" and improve well-being, a new approach has been designed and implemented. The method combines botany and mindfulness activities, developed as a proactive learning experience during guided walks, to positively influence families regarding plant science through the exploration of monumental trees located in different urban gardens of Coimbra, Portugal. This short-term program, developed for non-formal learning settings, was performed during a Summer Science Program promoted by "Ciência Viva", the Portuguese Agency for Scientific and Technological Culture. During the botanical and mindfulness activities carried out, public awareness about monumental trees was enhanced through the "Tree of Emotions" activity performed at the end of the botanical guided walk. We measured the effect of this activity by assessing the categories through which participants relate to trees. An open-ended questionnaire was enacted, and content analysis was

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used. The analysis can be broken down into seven categories: ornamental and aesthetic; subjective, affective, and well-being; cultural; dendrometric; morphological; biological and environmental; and anthropomorphic. The most categories identified by participants are subjective, affective, and well-being experiences, revealing the scientific aspects explored. The results suggest that botanical guided walks combined with mindfulness exercises can be an efficient tool for the general public to establish affective links with trees and their surrounding spaces as well gain botany awareness, recognizing its importance in daily life.

Key words

botanical activities; Trees of Public Interest; people–plant interaction; non-formal learning; outdoor programs; mindfulness.

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INTRODUCTION

The expression "monumental trees" has been adopted to refer to ancient trees (Haw, 2014), large, old trees (Lindenmayer et al., 2014; Liu et al., 2019), and other trees that represent a living memory about the historical and cultural identity of communities, also related to aesthetics and subjective enjoyment (Pederson, 2010; Blicharska and Mikusiński, 2014). Trees with special features, such as their longevity or featuring in old tales, are loved by communities and cultivate unusual social ties (Moon, 2014). Large, old trees are known to have important scientific and environmental attributes (Lindenmayer, et al., 2012, 2014), such as actively fixing large amounts of carbon compared to smaller trees (Stephenson et al., 2014), maintaining critical ecosystem functions (Lutz et al., 2018), or providing habitat for a variety of native species (Van der Hoek et al., 2017). In Portugal, trees that are distinguished from others of their species due to their size, design, age, rarity, or other natural, historical, cultural, or aesthetic features have been protected by legislation since 1938. Such trees are often called "Trees of Public Interest." Once listed as being of public interest, monumental trees become living monuments and, as such, subject to certain advantages and constraints.

In general, however, and despite the value they represent, trees are disproportionately vulnerable in many ecosystems worldwide because of human activity (Lindenmayer et al., 2014; Patrut et al., 2018). Even with global concern about loss of biodiversity, strategies for protection of biodiversity—and plant biodiversity in particular—cannot reduce such loss without increasing public awareness of environmental problems (Fančovičová and Prokop, 2011). However, this is especially challenging since direct contact with nature

has tended to decrease within modern society (Laaksoharju and Rappe, 2017). Indeed, children are becoming disconnected from nature, for a variety of reasons, including urbanization and loss of green space (Bertram and Rehdanz, 2015) and perceived risk of nature, parental fears, or control (Moss, 2012). This leads to serious consequences for attitudes of students and the general public toward the environment and how they perceive nature (Lohr and Pearson-Mims, 2005). For these reasons, it is particularly important to stimulate the pro-environmental values and behaviors of the public (Bogner and Wiseman, 2004). Kattmann (2000) has shown that student interest in biology decreases as age increases, and by the time they become adults, knowledge about biodiversity issues has dissipated. This seems to be consistent with the Eurobarometer (2013) "Attitudes Towards Biodiversity" survey, which found that, across the European Union (EU), less than half (44%) of Europeans have heard the term "biodiversity" and know what it means.

In fact, concerning plant biodiversity, the phenomenon of "plant blindness" has been used to justify the inability to see or notice plants in one's environment, leading to the inability to recognize their importance in the biosphere and in human affairs (Wandersee and Schussler, 2001). To overcome this trend, it is important for people of different ages to increase direct tactile interaction with plants (Neiman and Ades, 2014; Schreck Reis et al., 2014) through educational science awareness actions where participants can focus on monumental trees. As Fančovičová and Prokop (2011) have shown, this strategy is a suitable alternative to conventional biology courses, to positively influence participants' attitudes toward and knowledge of plants. This idea was also reported on by Lohr and Pearson-Mims (2005), who showed that children's active and passive interactions with plants influence their attitudes and actions toward trees and gardening as adults. In fact, children are more likely to respect trees if they plant and care for them, observing them as they grow and bloom (Viana, 1999). Other studies have showed that playing in nature during the early years forms children into environmentally responsible adults (Chawla, 2015; Broom, 2017).

Outdoor educational programs can be used to promote nature experiences with a positive impact. These interactions stimulate participants' curiosity, sense of empathy for creatures, responsibility for and unity with nature (Dienno and Hilton, 2005), and are also related to children's problem-solving capacities and emotional and intellectual development (Kellert, 2012). Outdoor family activities can play an important role in exploration and discovery, leading to new knowledge acquisition by members of all ages in an easy and pleasant way (Nadelson, 2013). A study conducted by Laaksoharju and Rappe (2017) showed that children's (7 to 12 years old) use of trees in urban spaces increased gradually as their connection with such spaces developed after a garden camp. Trees provided materials, play space, and activities that responded to children's needs.

Additionally, contact with nature has been shown to improve physical and mental health by reducing stress and pain (Kohlleppel et al., 2002; Tsunetsugu et al., 2007; Karjalainen et al., 2010). These studies give consistent evidence that human bodies and minds evolved simultaneously and interdependently. Hinds (2011) proposed that wonderment with the environment allows an individual to experience an uncomplicated state of mind, similar to "mindfulness." This psychological process is commonly defined as a certain

way of paying attention, in which attention is purposefully and non-judgmentally brought to the present experience on a moment-to-moment basis (Kabat-Zinn, 1990). This approach enhances the impact of experiences in nature and strengthens connectedness to nature (Howell et al., 2011). Several potential benefits are associated to mindfulness practice, such as increased body awareness, vitality, levels of concentration, productivity, creativity, and the ability to recognize and accept thoughts and emotions; reduced stress and anxiety levels; better overall emotional well-being and sleep; increased self-awareness and ability to challenge habitual thoughts and reactions to situations; and improved overall mental and physical health (Brown and Ryan, 2003).

Despite an apparent increase in understanding the role of trees in promoting both human and ecological health, and in representing opportunities for social interactions and behaviors (Coley et al., 1997), the specific use of the term "monumental tree" has not been developed in detail. These ideas underpinned the development of this project in which the link between botany and the mindfulness approach is used to develop science-awareness programs about monumental trees. The programs combine botanical exploration with mindfulness activities that increase concentration and favor a connection of the participants to the surroundings, with the intention of contributing to an increase in interest and curiosity about monumental trees, in particular those located in common green spaces of an urban city. This project aims to prevent "plant blindness" and, simultaneously, to promote intergenerational learning in botanical exploration, specifically through the exploration of a specific group of trees, so-called "monumental trees," a category often largely ignored by the population. Thus, this study contributes to the literature on science communication by analyzing practical and theoretical methodologies on family programs in the context of non-formal learning settings, as well as assessing the effects of botanical guided walks on children and adults' pro-environmental attitudes and their emotions and intentions with regard to monumental trees. The tasks carried out allowed interaction between participants as well as stimulated curiosity and the spirit of discovery. Participants were encouraged to hug a tree, walk in silence, listen to the sounds of nature, observe and describe organisms supported by the trees, measure a tree, and/or describe an emotion or feeling.

Our study aimed to: (1) reduce "plant blindness" in children and adults, especially in relation to trees with monumental features; (2) promote botany to a non-specialist public, in a non-formal learning setting; (3) enhance recognition of scientific education and literacy for their contribution to the preservation of communities' cultural and natural heritage; and (4) develop botanical and mindfulness activities, in outdoor contexts, as a way of sparking interest and knowledge in botany, and monumental trees in particular.

RESEARCH DESIGN AND METHODOLOGY

Activity setting

The project "Monumental Trees: Walk to Well-Being" was developed within the context of a nationwide Summer Science Program, promoted by Ciência Viva - Portuguese Agency for Scientific and Technological Culture. The sessions were carried out in the city of Coimbra, located in the center region of Portugal, and were included in the Events

of the Exploratório - Coimbra Science Center, in partnership with the Psychology Workshop Center. Four sessions were held over two days (26 July and 19 August 2015). Due to the methodological approach used, the number of people in each group was restricted to 15 people per session to enable greater quality of interaction. All participants agreed to participate in the study on a voluntary basis, after they were given a detailed explanation of the investigation around participant interactions with monumental trees.

Preparation of the activity

The botanical guided walk was prepared by a researcher and a psychologist, involving a systematic and critical review of research on botanical programs and outdoor learning activities. Thirteen urban trees with monumental features were selected to be the focus of the outdoor learning activities (Figure 1) in different green spaces in the city of Coimbra. The trees were close enough to complete guided walk of 0.93 miles (1.5 km) over a period of three hours.

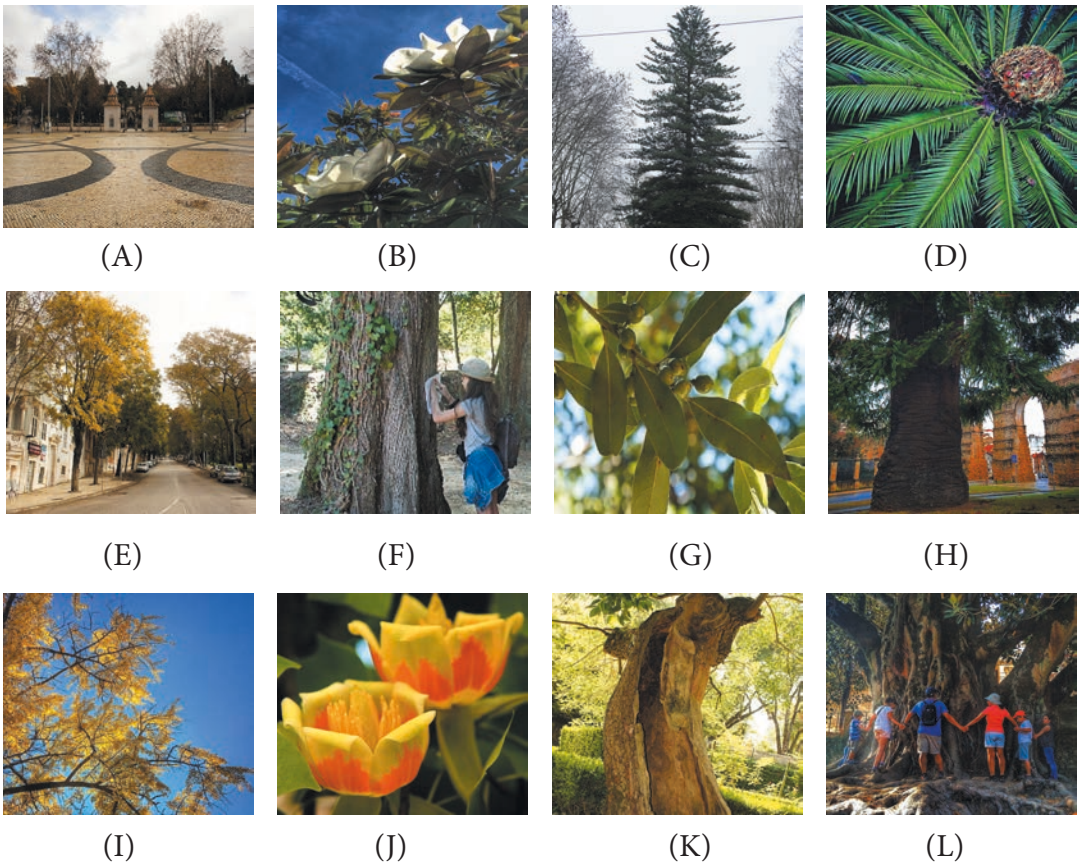

Figure 1. Monumental trees selected for the outdoor learning activities: (A) *Platanus x hispanica;* (B) *Magnolia grandiflora;* (C) *Araucaria heterophylla;* (D) *Cycas revoluta;* (E) *Tipuana tipu* and *Jacaranda mimosifolia* (both species planted along one avenue); (F) *Cupressus lusitanica;* (G) *Laurus nobilis;* (H) *Araucaria bidwilli;* (I) *Ginkgo biloba;* (J) *Liriodendron tulipifera;* (K) *Erythrina crista-galli;* and *(L) Ficus macrophylla.* All photographs by Raquel Pires Lopes (https://www.instagram.com/followmytree/).

Apart from their location, the selection reflects the diversity of trees within the city as well as their natural, scientific, historical, cultural, aesthetic, and ethnobotanical importance over time. All trees chosen for the guided walk are considered monumental trees and some have even become legally protected by Portuguese Law, becoming "Trees of Public Interest." *Ginkgo biloba*, *Liriodendron tulipifera*, and *Erythrina crista-galli,* located at Botanical Garden of the University of Coimbra, also have specific legal protection (Table 1).

Outdoor learning activities were selected taking into account the tree species, their significance, and the spaces explored. The hands-on and minds-on activities that were developed encouraged direct contact with the botanical elements, using the five senses.

At three of the stops, mindfulness activities were introduced to complement the botanical

Table 1. *Trees explored and activities performed during the botanical guided walk "Monumental Trees: Walk to Well-Being"*

		Activities approach	
Tree species per stop	**Specific aspects**	**Botanic**	**Mindfulness**
Platanus x hispanica (Mill.) Münchh	Aesthetic, scientific and dendrometric aspect	(a) *"Dendrometric data"*	(f) *"Respiration through cardiac coherence*" (g) *"Breathe deeply*"
Magnolia grandiflora L. *Araucaria heterophylla* (Salisb.) Franco *Cycas revoluta* Thunb.	Aesthetic, age, scientific and dendrometric aspect	(a) *"Dendrometric data"* (d) *"Living fossil"*	
Tipuana tipu (Benth.) Kuntze *Jacaranda mimosifolia* D. Don	Aesthetic and cultural aspect	(b) **"***Observe treetops***"**	
Cupressus lusitanica L. *Laurus nobilis* L.	Dendrometric and cultural aspect High representativeness	*(a) "Dendrometric data"; (b) "Drawing a tree bark"; "Observe tree-tops"; "Discovers the smell of trees"*	*(h) "Awakening sounds and breaths"* *(i) "Explore the five senses"*
Araucaria bidwilli Juss.	"Trees of Public Interest" by Portuguese Law	(e) *"10 rules to visit monumental trees without damage!"*	
Ginkgo biloba L. *Liriodendron tulipifera* L. *Erythrina crista-galli* L.	Age, dendrometric, scientific, historic, cultural and aesthetic aspect	(a) *"Hug a tree"; "Tree ID";* (c) *"2000 species in a tree, let's find them!";* (d) *"Living fossil"*	(j) *"Grounding*"
Ficus macrophylla Desf. ex Pers.	Dendrometric aspect	(k) *"Tree of Emotions"*	

activities. These methodologies determined the development of tasks to promote connectivity and proximity between monitors, participants, trees, and the spaces explored (Table 2).

"Tree of Emotions" Data Collection Instrument and Analysis

This study employed a qualitative research design using researchers' observations and semi-structured interviews with open-ended questions assessed through content analysis collected during the "Tree of Emotions" exercise, completed at the end of the session at each guided walk. During this activity, participants were asked to choose which of the 13 trees explored reflected four different emotions—joy, fear, sadness, and love—according to their individual exploration during the guided walk. We chose this final exercise to gather participants' observations during the botanical guided walk and to determine attitudes, opinions, perceptions, and knowledge about the monumental trees explored along the different stops. An excerpt from our interview is provided below:

Researcher (R): "*What feeling (joy, fear, sadness, and love) do you associate to the trees explored and why?*

[**Joy**]

Child (C): "*The leaves have a similar format to a cat face, that I like"* [*Liriodendron tulipifera*]

(C): "*They have funny fruit"* [*Jacaranda mimosifolia*]

Adult (A): "*They have a festive name*" [*Jacaranda mimosifolia*]

(A): "*The happiness in seeing my children play around*" [*Liriodendron tulipifera*]

[**Fear**]

(C): "*It is hunchbacked like an old man"* [*Erythrina crista-galli*]

(C): "*It seems afraid and embraces other trees*" [*Ficus macrophylla*]

(A): "*I'm afraid that giant pine cones fall on me*" [*Araucaria bidwilli*]

(A): "*Flowers attract many bees that I am afraid of*" [*Liriodendron tulipifera*]

[**Sadness**]

(C): "*It seems sad and needs a hug*" [*Erythrina crista-galli*]

(C): "*It is old, and has a big hollow log… It looks very sad*" [*Erythrina crista-galli*]

(A): "*The tree is incomplete with a hollow log, it has died back*" [*Erythrina crista-galli*]

(A): "*The trunk color is not festive*" [*Ficus macrophylla*]

[**Love**]

(C): "*Is like a house, I fit in it*" [*Erythrina crista-galli*]

(C): "*Two leaves together are a heart*" [*Ginkgo biloba*]

(A): "A *plant that provides shelter and food to many beings, promoting biodiversity and this is a manifestation of the 'love of nature' sharing for all living beings*" [*Liriodendron tulipifera*]

(A): "*Because of its medicinal properties, which makes us well, like love [does]*" [*Ginkgo biloba*]

Table 2. *Description of the activities performed during the botanical guided walk "Monumental Trees: Walk to Well-Being."*

	Botanical Activity	**Description**
(a)	**"***Dendrometric data***"; "***Hug a tree***"**	Determining certain dendrometric parameters related to size, height, and age using measuring instruments (tape measure, rope) or by hugging.
	"*Tree ID***"**	Filling out a document about the tree data (e.g., scientific name, common name, dendrometric parameters, leaf shape, bark).
(b)	*"Drawing tree bark"; "Observe treetops"; "Discover the smell of trees"*	Analyzing particular features about the trees.
(c)	*"2,000 species in a tree, let's find them!"*	Stimulating scientific curiosity through the exploration of botanical elements.
(d)	*"Living fossil"*	Stimulating scientific curiosity through the exploration of their ecological importance.
(e)	*"10 rules to visit monumental trees without damage!"*	Exploring the parameters that are used for "Trees of Public Interest" in accordance with Portuguese legislation, and the rules to visit them.
	Mindfulness Activity	**Description**
(f)	*"Respiration through cardiac coherence"*	Breathing technique to promote the balanced communication between the heart and the brain, helping to avoid negative feelings.
(g)	*"Breathe deeply"*	Focusing on the sensations of breathing, getting off autopilot to become aware of the present moment.
(h)	*"Awakening sounds and breaths"*	Closing the eyes to relax and feel the sensations present, such as breathing, as well as expand the focus of attention to surrounding sounds.
(i)	*"Explore the five senses"*	Using the five senses to explore the trees (e.g., feel different textures and scents, observe components of each tree).
(j)	*"Grounding"*	Feeling the importance and the necessity of stability and rooting either trees and humans.
	Botanical and Mindfulness Activity	**Description**
(k)	*"Tree of Emotions"*	Choosing a tree along the path that can be identified with certain emotions (joy, sadness, anger, and fear). These emotions are experienced throughout our lives constituting the inner signs of our body.

Responses were recorded by the three researchers during the collective sessions, and notes were later discussed. Participants' key monumental tree concepts were analyzed and categorized through interpretive research by four researchers, two specializing in psychology and two in biology. The researchers validated the answers collected in a collective discussion. The process was repeated to add or discard new coding. This procedure involved all the researchers. Tables were created to present and categorization all answers given.

Participants

Approximately 39% (n = 23) of the 59 participants in the Science Summer Program were children aged 2 to 16 years old. Adults between the ages of 21 to 71 years old made up 61% (n = 36) of the participants in the program.

RESULTS

The results presented were obtained from the answers collected during the "Tree of Emotions" exercise. From 236 answers expected (4 questions to 59 participants), a total of 141 answers were obtained (60% response rate): 117 from adults (83%) and 24 from children (17%). Non-response was lower in adults (28%) than children (72%). This may be explained by the fact that some children felt embarrassed of speaking in public or preferred not to answer. In some cases, the whole family worked together in filling the brochure for the guided walk and then one of the adults was the speaker.

Categories emerging from the "Tree of Emotions" activity

During analysis of the 141 answers obtained in the "Tree of Emotions" exercise, key monumental tree concepts identified by participants were analyzed and categorized into qualitative categories. Seven categories of concepts emerged and were useful for grouping participants' answers (Table 3). Each answer could have elements that were grouped into more than one category since the overall response reflected several interesting ideas and concepts. In this way, the database is richer.

Both children and adults justified their answers using subjective, affective, and well-being–related aspects with positive and negative feelings (43% of adult and 28% of child responses). Some observations showed concern about physical damage to trees caused by human activity (e.g., "I was sad to see roots damaged by works on the roadside"), dripping sap, or the attraction of insects. Better informed participants also focused on certain problems of particular concern, such as the proliferation of invasive and exotic plants (e.g., "I saw some invasive trees in the Mermaid's Garden and it scares me because they will not give space to our species").

Participants also frequently mentioned morphological features of the trees (19% of adult and 28% of child responses). For example, many participants noticed the giant cones of *Araucaria bidwillii,* the flowers of *Magnolia grandiflora, Jacaranda mimosifolia,* and *Liriodendron tulipifera*, and the leaves of *Ginkgo biloba* and *Liriodendron tulipifer*a). Both adults and children also mentioned the oldest tree found on the walk, *Erythrina crista-galli*, which is over 200 years old and has a big hole in the trunk contributing to its dieback.

Analysis of the results shows that ornamental and aesthetic value of trees in urban landscapes (14%) and cultural aspects (6%) only occurred in answers from adults. Biological and environmental values occur in 9% of all participants' answers. Regarding cultural

Table 3. *Representative examples of excerpts from the answers given and emerging categories from the question* "What feeling (…) do you associate to the trees explored and why?*" from the exercise "Tree of Emotions".*

		Occurrences		
Categories	**Description**	**Children (C)**	**Adult (A)**	**Excerpts from the answers given**
Ornamental and aesthetic	Related to tree's presence in the landscape, by adding shape and beauty through their flowers, fruits, or other seasonal aesthetic aspects	0	38	(A)**:** *"They give us shade"; "Common in parks and gardens"; "Form very beautiful malls where I like to walk"; "Are pruned"; "Makes the city beautiful"; "Very common in Portugal"; "Have an ornamental use"; "Beautifies the gardens"*
Subjective, affective, and well-being	Reflects individuals' thoughts and feelings (good and bad), life satisfaction, sense of home and family and their own life experiences, by the combination of cognitive judgments and affective reactions	16	114	(C): *"They have fun leaves"; "I don't like cats"; "Gives me fear"; "Seems to be very sad"; "Fun fruit"; "The leaves look like a heart"* (A): *"It has a festive name"; "It has leaves like cats and I don't like them"; "I am afraid of bees"; "I am afraid that a cone would fall on me"; "It gives me pity to look at it"; "I feel sad"; "I have affection for it"; "It transmits fear to me"; The happiness of seeing my children play around"; "It reminds me of my childhood"; "Gives me joy"*
Cultural	Related with the symbolic value of trees, and sense of community that they inspire	0	15	(A): "When blooming, it is a landmark of the city"; "A strong connection to the city and its students"; "The flowers have the colors of the flag"; "It reminds me of a cemetery and death"

Dendrometric	Related with age and physical characteristics such as habit, shape, and tree measurements (Circumference at Breast Height [DBH], height or canopy dimension)	9	17	(C): "*It is too old*"; "*Too big*"; "*Because it is old and has a huge hole*"; *"It's huge"* (A): "*Size*"; "*The oldest tree we know*"; "*It is curved*"; *"It's huge"*; "*Too big*"; "*Is very old*"
Morphological	When description of botanical elements such as roots, trunk, bark, leaves, flowers, fruits, or seeds are present in the answers	16	51	(C): "*The tips are separated (trunk and branches)*"; "*The leaves have a similar format to a cat face*"; "*They have different leaves*" (A): "*Giant cones*"; "*Trunk color*"; "*Great growth*"; "*Big fruit size*"; "*Golden leaves*"; "*Hollow log*"
Biological and environmental	Associated with the ecological functions of trees, also related with promotion of biodiversity and medicinal properties	2	24	(C): "*Grabs other plants*"; "*Roots falling*" (A): "*Filtering air pollutants*"; "*Survived the Hiroshima bomb*"; "*Choke*"; "*It has a chemical substance that can paralyse the body*"; "*They have poison*"*;* "*It looks dead*"; "*They kill trees around them*"; "*Trees that give shelter and food to many beings, this is a manifestation of nature's love*"; "*With medicinal properties*"; "*Pigmentation of leaves*"; "*Sap drips*"
Anthropomorphism	When trees are personified and attributed human features	14	8	(C): "*Hunchbacked like an old man*"; "*Needs a hug*"; "*Seems afraid and embraces the other trees*" (A): "*Seems to cry*"; "*Selfish, looks like an octopus*"; "*It has bad behaviors, like many people*"

aspects of the trees, we found a connection between tree species and the city, which has an impact on local people. For example, when *Tipuana tipu* and *Jacaranda mimosifolia* are flowering, they have the colors of the city flag. Further, *Liriodendron tulipifera* was frequently referred to as "Árvore do ponto" ("Exam tree"), with a national reference as common name, because past university examination periods coincided with the flowering of this species. Other adult answers reflected dendrometric data (6%) and anthropomorphic features (3%).

Besides morphological aspects, children's answers focused on anthropomorphic features (24%), where trees take on human traits. The descriptions were so realistic that one can even identify the tree despite no indication of a name. Children's answers also revealed dendrometric features (16%), such as size and height of the trees, for instance. Fewer answers reflected biological and environmental values (4%). None of the children's answers reflected ornamental and aesthetic or cultural aspects (Figure 2).

DISCUSSION

The activities used in this study achieved a dynamic, cooperative, and playful learning involvement between children, their families, and the trees and places explored. The time provided to participants generated greater awareness and a more effective appropriation of the activity, according to the principles of mindfulness.

A large majority of participants were able to associate the emotions (joy, fear, sadness, and love) to the trees explored during the guided walk, and we were able to group the answers into seven categories (ornamental and aesthetic; subjective, affective, and well-being; cultural; dendrometric; morphological; biological and environmental; and anthropomorphic). The answers revealed the use of information provided during the botanical guided walk and were rich and different between the two groups of participants. This can be explained by the differences in age, life experiences, and cognitive development. In the case of the

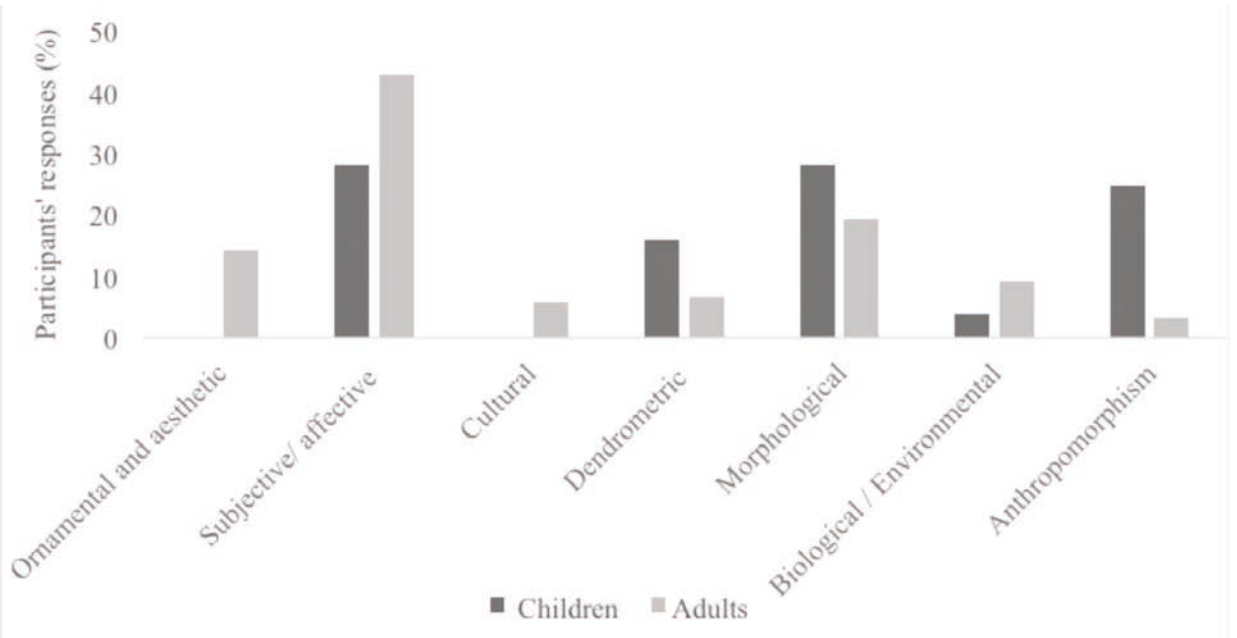

Figure 2. Seven conceptual categories in participants' answers to the "Tree of Emotions" activity: 117 for adults (A) and 24 for children (C).

anthropomorphism category, for instance, the participants' descriptions were very realistic and adapted to their respective ages. In the children's answers, there seemed to be a naïve perception, while adult responses seemed to reflect human behavior. These observations on anthropomorphism are in line with previous research that showed that trees are often seen as carrying symbolic meaning (Appleyard, 1980, as cited in Dwyer et al., 1991).

For both groups, the most common answers were in the subjective, affective, and well-being category. Participants' responses about the monumental trees evoked both positive and negative emotional reactions. Exploration and discovery of the trees fired the imagination and emotions of participants, as Blicharska and Mikusiński (2014) showed, but also caused loathing or association with beauty or ugliness, which reflects a cognitive, sensory, and individual perception about the tree and the place around. These results are consistent with previous studies about public perception of street trees. In the Schroeder and Cannon (1983) investigation, trees were considered the most important element of urban green spaces, with good and bad impacts to the general public. Dwyer et al. (1991) showed the significance of urban trees and forests to urban residents. Further, Lohr and Pearson-Mims (2006) found that people prefer scenes that have trees more than scenes that have inanimate objects, and have more positive emotions when viewing trees compared to inanimate objects. Some of the occurrences of negative emotions, such as the sadness or fear associated to trees, were deliberately used as discussion topics with the aim of demystifying certain conceptions and generalized ideas without a scientific basis in order to help people to notice and engage with plants. In addition, in most of the occurrences of negative emotions, these were expressed through displays of concern for the trees and not negative emotions in relation to the trees themselves, which is a good indicator that the activities are on the right track to counteract the plant blindness phenomenon.

Regarding the presence of big trees, adults were impressed by their dimension, shape, and ornamental (e.g., shadow, beauty) and environmental importance (e.g., shade, air renewal). They also showed concern towards trees' abiotic (e.g., shading of buildings by trees), biotic (e.g., bees), and anthropogenic (e.g., root damage, pruning) impacts. Adjectives (e.g., *"attractive", "decorative", "beautiful"*) were often used to describe ornamental and aesthetic features of trees (e.g., canopy, flowers, leaves). These observations seem to be consistent with a past study that found that larger and older trees are the most attractive to the public (Schroeder and Cannon, 1983). Dwyer et al. (1991) also showed that streets with mostly large, old trees of a single species may appear attractive, but they are susceptible to sudden loss of scenic value due to damage, pests, and breakage and may be costlier to maintain, such as the Emerald Ash Borer, and its extensive mortality of ash (*Fraxinus* spp.) (Liu, 2017). In a more recent study, a survey conducted in Morelia, Mexico, revealed that people prefer tall, leafy, and shady trees and consider that trees were beneficial to them, and for the city, by improving environmental quality, and aesthetically improving the landscape (Camacho-Cervantes et al., 2014).

Despite previous studies stating that air quality is less immediately perceptible than other physical benefits, such as reduced noise and wind speed (Schroeder et al., 2006), responses given by adults reflect trees' capacity to filter air pollutants. Additionally, there seems to be a strong environmental concern in the importance attributed to trees' representation

of biodiversity since plants, animals, and other organisms depend on them.

Researchers also noticed that participants paid more attention to colorful tree species, which was consistent with Kaufman and Lohr (2004), who demonstrated that people respond more positively to plants of some colors than others. Some botanical features could not be observed on the trees, although adults nonetheless recognized the species by their characteristic elements (e.g., flowers, fruits). Such absence of seasonal features sparked a discussion on the importance of repeating the botanical exploration in other seasons, namely spring, fall, or even during the winter, to give participants the opportunity to recognize the changes of the plant during the year (Schreck Reis et al., 2014).

Cupressus sempervirens was not explored, but the columnar shape of the species was mentioned during the guided walk. This species was associated with sadness, since it is traditionally used in cemeteries. Several studies showed that people exhibit positive emotional and physiological experiences in their responses to trees in general or to trees with wide, spreading, and globular canopies (Dwyer et al., 1991; Lohr and Pearson-Mims, 2006). Crown shape and density were important parameters mirroring human preference of large spreading street trees rather than columnar trees in Germany (Gerstenberg and Hofmann, 2016). This investigation also showed that a high, two-dimensional crown size to trunk height ratio and a high crown density could be used to predict people's preferences regarding deciduous trees (Gerstenberg and Hofmann, 2016).

Passive observation and active exploration contribute to building positive memories of trees and certain notions about them. These also contribute to improving values and attitudes and to developing environmental responsibility within a family context. Such activities are a key component for increasing scientific literacy interactions, and have been recommended in several studies (e.g., Drissner et al. 2010; Nadelson 2013; Schreck Reis et al., 2014).

As Dwyer et al. (1991) ask, (1) "How many remember a big tree in front of their parents or grandparents home, and the deep sense of loss when it was removed?"; (2) "How many individuals have planted a tree as a child and watched it mature as they did?"; and (3) "[How many remember] planting trees as 'living memorials' to remember *loved ones*?" (Dwyer et al., 1991, p. 277). A good example of this was a mother with two children that had previously participated in other summer science programs related to trees, due to her children's interest. The example given is consistent with the Neiman and Ades (2014) study, suggesting that outdoor programs promote emotional affinity, giving an individual a concrete memory and a change in attitude for a long time after the activity. Furthermore, as Lohr and Pearson-Mims (2005) have already showed, childhood experiences with nature influence adult sensitivity to trees, and that influence is very strong.

Participant answers also revealed their memories of trees were related to daily life. Some of them, living in Coimbra, mentioned that it was a pleasure to rediscover trees present in their everyday lives that they had never looked at with enough attention. They also said that, from that day forward, they felt that they would pay closer attention to those trees. This observation is consistent with other studies (Dwyer et al., 1991; Sanders, 2007)

that have shown the importance of using everyday learning contexts as an opportunity for children and their families to interact with trees and the places in which they live.

During the final reflection, several participants mentioned that pauses during the guided walk were a way of "*relaxing*," and allowed them to "*be calmer and become involved with the space and each other.*" Our results are consistent with Mullaney et al. (2015), who observed that, besides the aesthetics and provision of shade, most residents prefer the calming effect of the trees. In fact, combining mindfulness practice with direct contact with trees, not limited to a theoretical presentation of scientific subjects, allowed a greater focus on and connection to the green spaces explored. This approach can be a powerful tool toward facilitating a more effective interaction between people and natural elements, contributing to increased interest and curiosity in monumental trees.

CONCLUSIONS

Our experimental study has contributed to filling a gap in outdoor learning programs by using monumental trees to reduce "plant blindness." In addition, the project used intergenerational interaction between children and their parents to explore innovative methodologies for addressing botanical themes, at the same time using a mindfulness approach to promote well-being. The aim of the study, to explore monumental trees, was also innovative since there is a lack of studies about public interaction with this specific group of trees. On the other hand, monumental trees and other plants are present in all cities and are often unnoticed.

The explorations carried out helped participants to notice and engage with plants, thereby sparking interest and increasing knowledge about them. If positive emotions demonstrate appreciation, care, and attention toward the plants, negative emotions such as pity and suffering for the trees themselves also show concern and appreciation for plants. That is, negative aspects pointed out reveal positive outcomes with regards to the objective of the study: the prevention of the plant blindness phenomenon. Aspects related to insensitivity or contempt for plants were not observed.

Methods applied in the study (hands-on and minds-on activities, open-public spaces, botanical and mindfulness approaches) contribute to providing participants with an opportunity to create a more positive attitude toward plants and, specifically, monumental trees. Our methodology was consistent with previous studies and can be adapted to investigate how attitudes toward trees vary through a science program, even such a short-term program as this one. Our survey results support a positive overall assessment of trees and botanical subjects. Contact with participants provided important feedback used to measure strategies and adjustments of the project, to be applied in further sessions.

Our findings provide increased understanding in our efforts to counter the plant blindness phenomenon by showing the interest of non-specialist public in educational science awareness experiences as a way of sparking interest and sharing knowledge in botany. Further research on outdoor activities in formal, non-formal, and informal learning applied to direct experiences with monumental trees and on how to improve the public's knowledge about that matter is needed in the future.

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