GAMIFYING URBAN NATURE EXPERIENCES

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With 3 figures
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Summary: Nature experiences are important drivers of environmental awareness and responsibility, as literature has shown that people who feel a greater connectedness with nature tend to be more active in conservation action. Despite this, recent studies have shown that nature contact within urban space is in decline, which has led scholars to call for novel ways to reconnect urban dwellers with nature. With this in mind, this paper explores the potential of gamification to co-create engaging and immersive experiences of urban nature, following the insight that the sensory and emotional dimensions of nature experiences are crucial for the development of nature connectedness and conservation awareness. We draw on a qualitative study on the emotional experience of a mixed-reality narrative developed for an historical botanical garden in Lisbon, in which game elements, namely treasure-hunting and rewards, are integrated into an urban nature experience. The study devised a methodology inspired by non-representational and creative methodologies, which comprised a series of performative workshops aimed to understand the emplaced emotional and sensory connections with the environment during the experience of the gamified mixed-reality narrative. Our findings allowed us to understand how gamification techniques in urban nature experiences can stimulate nature connectedness by encouraging sensory contact and appreciation of beauty, and promote environmental responsibility by emphasizing conservation issues. We conclude the paper by discussing the possibilities of further applications of gamification within the design of urban nature experiences.

Keywords: Urban ecology, protection of nature, environmental responsibility, gamification, mixed reality, Lisbon

1 Introduction

The quality of nature experiences in the city can play a crucial role in global nature conservation. Urban nature experiences are fundamental for the health and well-being of city dwellers, not only due to the physical health benefits that stem from contact with nature, but also due to the positive effects of natural landscapes in mental health (Birch et al. 2020, Dobson et al. 2021). But urban nature experiences can also become important drivers of environmental awareness and responsibility, when they are profound enough to connect urban dwellers with nature (Prévot et al. 2018, Sato et al. 2021). Despite this, studies on nature experience in the city have shown that nature contact within urban space is in decline (Soga & Gaston 2016, Soga et al. 2016, Soga et al. 2018). Taking this into account, researchers and practitioners are actively seeking innovative ways to reconnect urban dwellers with nature. Such endeavour is urgent, given that most human population lives in cities and the percentage of urban population is projected to increase throughout this century (Hartig & Kahn 2016). This line of research has often explored how digital media can co-create engaging and immersive experiences for better well-being, conservation behaviour or public participation (Shwartz 2017, McEwan et al. 2019, 2020). Interestingly, the potential of gamification to co-create more immersive and engaging nature experiences in urban environments has been mostly neglected, despite the popularity of this approach in other user design contexts (Chou 2015, Stieglitz et al. 2017, Akmentina 2023).

With this in mind, the objective of our study is to explore the potential of gamification techniques, namely treasure hunting and reward systems, to co-create engaging and immersive experiences of urban nature. More precisely, we are interested in: (i) understanding how treasure hunting can direct attention in urban nature experiences and promote sensory contact and appreciation of the beauty of the environment, thereby enhancing nature connectedness; and (ii) understanding how reward systems can motivate participants and promote environmental responsibility by emphasizing conservation issues. Our research draws on the case study of a mixed-reality narrative developed for the Jardim Botânico da Ajuda, an historical botanical garden in Lisbon. The mixed-reality narrative was designed to co-create an urban nature experience in which game elements, namely treasure-hunting and rewards, are integrated into an experience of an urban nature area.

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This article is further divided into four sections. First, we review current literature on urban nature experiences, discussing the value of such experiences and the different approaches that have been implemented or suggested to counter the decline in nature connectedness within cities. Afterwards, we present our case study and the qualitative methodology we implemented to study the user experience. Thirdly, we present the results of our study, showing how the gamified urban nature experience stimulated nature connectedness by encouraging sensory contact and appreciation of beauty, and how it promoted environmental responsibility by emphasizing conservation issues. We conclude the paper by discussing the possibilities of further applications of gamification within the design of urban nature experiences.

2 The promotion of urban nature experiences

There is a significant link between nature experiences and conservation action, as people who spend more time in nature and feel a greater connectedness with nature tend to be more supportive of conservation policies and more willing to engage in sustainable practices (Prévot et al. 2018). This link has been found in different forms of contact with nature, from leisure practices to gardening and workplace activities, and different types of publics, from children to elder population (Egerer et al. 2019, Lacoeuilhe et al. 2017). This has led authors such as Sato et al. (2021) to argue that the valuation of ecosystems must take into account its potential for fostering connectedness to nature, as this is directly linked to the willingness of urban dwellers to pay for forestry services. Nature connectedness has been defined as a person's sense of connection to nature, which entails awareness of one's embeddedness in the natural world, sense of agency regarding one's impact on natural systems, and familiarity and comfort with being in nature (Nisbet et al. 2009, 2011). It has been argued that nature connectedness is attained through direct contact with nature, especially when involving: (i) sensory contact; (ii) strong emotional responses; (iii) meaningful interactions, and (iv) appreciation of beauty (Lumber et al. 2017, McEwan et al. 2020, Dobson et al. 2021).

Despite the positive outcomes of nature experiences, it has been noted that the number of people who have daily contact with nature has been diminishing for decades (Cox et al. 2017). For this reason, scholars have argued that, alongside the sixth great extinction event, there is also a process of 'extinction of experience' (Pyle 1993, Sushinsky et al. 2017). Among the reasons for this extinction of experience are the fact that most human population now lives in cities and are far from natural 'wild' sites where encounters with nature are most likely, and that people have come to prefer sedentary indoor pastimes that involve the use of technologies such as televisions, smartphones, or computers (Soga & Gaston 2016). The extinction of experience leads to disaffection toward nature, which in turn leads to a lesser engagement in nature conservation action and may contribute toward worse health and well-being (Soga et al. 2016). The lack of nature experiences among children is especially concerning because it is during child development that lifelong values of nature connectedness are formed (Soga et al. 2018, Cleary et al. 2020).

With this in mind, scholars have called for a greater attention to the promotion of nature experiences in urban areas, given that most human population lives in cities (Dunn et al. 2006). More often than not, such calls have been directed to urban designers and landscape architects and have been concerned with the increase of public green space in urban space (Church 2018, Zepp 2018). Although the increase of public green space has its evident merits, namely in terms of the ecosystems services that these areas provide and their benefits for public health (Völker et al. 2013), it is less obvious how the availability of public green space alone contributes to a greater nature connectedness and willingness to support conservation action and the protection of biodiversity (Liu et al. 2022). For instance, Pett et al. (2016) noted that although people prefer sites with higher biodiversity and relate biodiversity with a greater personal well-being, they generally have a limited ability to accurately perceive the biodiversity surrounding them. Similarly, Shwartz et al. (2014) have found that enhancing biodiversity in public green space does not necessarily produces greater nature engagement because individuals underestimate biodiversity and do not recognize changes in the bio-landscape. Recent studies suggest that this is because people's idea of diversity is related to experiential sensations in nature, rather than objective and quantitative evaluations of biodiversity (Voigt & Wurster 2015, Palliwoda & Priess 2021, Hatty et al. 2022). Taking the importance of experiential sensations for the appreciation of nature into account, scholars have been concerned with how urban green spaces can promote more intense sensory contact with nature, given that this might foster greater environmental knowledge, awareness and, hopefully,

conservation action. Here, sensory contact refers to the experience of the sensory features of the natural world, especially but not limited to visual (colour, shape, depth, etc.), sonic, or olfactory features. These features might be perceived individually, but also as whole in the form of ambiance (Williams 2017, Biglin 2020). Practices such as urban agriculture, foraging, gardening, or bird-feeding have been highlighted as practices that may promote sensory contact and thus foster a greater connection with nature within cities (Fischer & Kowarik 2020, Lin et al. 2018, Birch et al. 2020).

Innovative digital approaches have also been proposed (Li & Nassauer 2021). For instance, Schuttler et al. (2018) have argued that citizen science initiatives may help reduce the extinction of nature experiences as they promote the cognitive and emotional aspects of experiences in nature. Scholars have also developed digital tools to foster contact with nature. For instance, McEwan et al. (2019, also McEwan et al. 2020) developed a smartphone app which allows people to identify the 'good things' they notice in urban nature, which can then be used to inform urban planning. Similarly, Radicchi (2019) developed an app that allows individuals to identify quiet areas within the city, which has been used by cities such as Berlin and Limerick to create Quiet Area Plans. Another set of initiative in urban nature experience design involves the use of digital arts and augmented reality in the co-creation of immersive and meaningful experiences (Shwartz 2017). The interest in the arts is related to the notion that urban nature experiences are more effective in fostering nature connectedness if they entail multisensory contact rather than passive visual observation (Clayton et al. 2017, Macaulay et al. 2022).

Despite these innovative digital approaches, there seems to be little to no attention to how gamification can transform urban nature experiences to promote greater environmental awareness. This is striking given that, among the various positive outcomes of gamification, it has been highlighted that gamification can significantly improve learning by providing a more immersive and engaging experience (Sanchez et al. 2020, Sailer & Homner 2020). A rare exception to this trend is the work of Davidová et al. (2022) on Co-De|GT, a gaming application that uses blockchain technologies to create a token-based game to encourage participation in biodiversity protection in a marginalised community in Grangetown, Wales. However, Co-De|GT focuses on creating and supporting an alternative economic model to regenerate local diversity, rather than focusing on nature experience. It is likely that gamification has been neglected by those interested in promoting urban nature experience because games are more associated to indoor pastimes and there might be concerns that the mediation of game interfaces minimizes direct contact with nature (Voordijk & Dorrestijn 2021). Notwithstanding, we contend that gamification might offer a way to direct attention in urban nature experiences and promote sensory contact and appreciation of the beauty of the environment which might anchor nature connectedness and environmental responsibility. Before we delve deeper into this, we first approach the concept of gamification.

Gamification broadly refers to the implementation of game design in non-ludic practices. It involves the introduction of game elements, including narratives, progressive ranking systems, awards, rules, collaboration techniques, and interfaces in 'serious' economic, political or social contexts. Gamification can operate in various degrees, from the introduction of a single game design element to the full transformation of a social practice into a gamified system (Chou 2015, Stieglitz et al. 2017). This approach has become significantly popular as a tool for creating user interfaces and user experiences in the last decade, and it has been applied in quite different contexts, such as social media, teaching, tourism, or health (Klock et al. 2020). The advantages of gamification are mostly linked to behavioural outcomes (Johnson et al. 2016). Gamified experiences tend to increase people's engagement with activities, spaces, and brands, as game elements provide feelings of fun, enjoyment and interaction, making people more motivated to engage with the proposed activities (Nobre & Ferreira 2017, Hassan & Hamari 2020). It has however been noted that gamification tends to increase short-term engagement, but not medium- or long-term engagement (Sardi et al. 2017). For this reason, gamification has been understood as a promising technique to be used in performative tasks that involve cognition, such as learning or public participation. For these reasons, gamification might be an effective solution to increase people's engagement and personal connection with nature.

Gamification raises significant ethical issues. While gamified systems can motivate engagement, they often do so without the users becoming completely aware of the nuances of those systems and their influence on their behaviours, which might lead to the reduction of the user's autonomy, resulting in exploitation and manipulation (Arora & Razavian 2021). Furthermore, taking into account that gam-

ification often involves storytelling, it can contribute toward social and political manipulation and the promotion of harmful discourses (Ging & Garvey 2018). For this reason, scholars have argued that the application of gamification techniques should include an ethical assessment (Thorpe & Roper 2019).

While gamification is more often associated with digital media, such as social networks and platforms, it has also found its way into urban design and planning. Gamification has been understood by city authorities as a significant tool for fostering civic participation, although it has been noted that gamification in this context might actually constrain open participation, given that a significant part of the urban population might lack access or skills to operate digital tools or reject gamified systems (Vanolo 2018, 2019, Yen et al. 2019, Latifi et al. 2022, Akmentina 2023). On the other hand, several urban actors, especially in tourism-oriented urban areas, are drawing on the gamification approach to co-create experiences with consumers (Xu et al. 2013).

In our study, we will focus on the introduction of two specific gamification techniques in urban nature experiences: treasure hunting and reward systems. Treasure hunting is a common gamification technique that is already being applied in the urban context, especially in consumption, cultural, and tourism activities (Economou et al. 2015, Wakao et al. 2015, Olssen et al. 2016). The advantage of this technique is that it invites users to roam around a certain area to find the 'treasure', thus suggesting users to engage in greater depth with the space they temporarily inhabit (Xu et al. 2017). Often, users are challenged to find a series of sites or items in a pre-defined order, which allows experience designers to define spatial paths that users must follow and guiding them to focus on specific nuances of that path (Bulencer & Egger 2015). Research in tourism has found that treasure hunting is a useful technique for encouraging interaction with sites and promoting learning in tourism experiences (Linaza et al. 2014, Xu et al. 2017). In addition to this, treasure hunting has been found to motivate users and is linked to increased satisfaction with consumption activities (Olsson et al. 2016).

Rewards systems are typically combined with treasure hunting. The reward system is also a popular gamification technique that is valued for sustaining the interest of users, as it adds novelty during the experience and provides positive emotional stimuli that might compensate feelings of tiredness, stress or frustration that gamified experience might cause (Lewis et al. 2016, Ahn et al. 2019, Alsawaier 2019). Reward systems consist of offering prizes to users for completing certain tasks or achieving certain status within a game. Such prizes can be manifold, including money or discounts, but can also simply entail access to new media. Reward systems are usually implemented to increase motivation and loyalty among users (Kavaliova 2016, Lewis et al. 2016, Ahn et al. 2019). However, research has shown that reward systems can be important drivers of motivation for learning, when users are rewarded for learning or rewarded with new information or novel media (O'Donovan et al. 2013, van Gaalen et al. 2021).

In the next section, we present an empirical study of a gamified urban nature experience that integrates these two techniques.

3 Case study and methodology

The Ajuda Botanical Garden is located in the Ajuda parish, in the vicinity of Lisbon's city centre, and it is the oldest botanical garden in Portugal. It comprises an area of about 3.5 hectares and contains about 1600 plant species. Our case study focuses on Origenes botanica, a mixed-reality fictional futuristic narrative developed for this garden in ESRI Story Maps by a multidisciplinary team from the Universidade de Lisboa, which included geographers, landscape architects, and graphical artists. The mixed-reality narrative was freely available for visitors of the garden between September 2021 and September 2023. Origenes botanica is akin to many mixed-reality apps that have been developed for urban green spaces in the last decade in the sense that they augment the experience of urban nature through digital interfaces (Fig. 1). However, while most apps focus on citizen science (such as iNaturalist, see Mesaglio & Callaghan 2021), user-generated content (such as Végétalisons Paris, see De Biase et al. 2018), or education (such as the Kew Gardens App, see Postolache et al. 2022), Origenes botanica attempts to co-create an engaging and immersive experience of urban nature through a gamified narrative, making it a strategic case for this study. Origenes botanica takes place in the two main segments of the Ajuda Botanical Garden. The first is the scenic segment of the garden, which is composed by a mix of topiary, bushes, flowerbeds, palms and large trees. The second is the scientific segment, where the plants are organized by global regions.

The narrative describes the arrival of a group of scientists at the Jardim Botânico da Ajuda in the year 2100, when the Sixth Great Extinction has un-

folded. The scientists are looking for plant species that can no longer be found in the wild, but still exist in the protected environments of cities. The digital narrative, which is a mix of graphic narratives and digital cartography, incorporates the game dynamic of the 'treasure hunt', as it guides users through the botanical garden to find the species that the scientists are looking for. It also incorporates a simple 'reward system', as each time a user finds a plant, they are presented with an interactive map that contextualizes the future past of the species, providing information on contemporary threats to conservation. After users find the six species that the scientists are looking for, the narrative is concluded by a discussion among the scientists regarding nature conservation actions that might prevent the extinction of species. In this sense, the narrative mixes an engaging dynamic of exploration with environmental educational.

Fig. 1: Origenes botanica interface. The figure depicts one of the interactive maps embedded in the narrative as part of the reward system. This interactive map is a tour map showing the global distribution of threats to one of the species in the garden. The figure depicts step 4 of the tour map, which focuses on the Mediterranean region. Source: Jardim Botânico da Ajuda.

In this study, we have undertaken performative workshops inspired by non-representational and creative approaches that seek to unveil the nuances of engaged in-practice emotional experiences. Non-representational and creative methodologies seek to engage research participants in performative activities that elicit the embodiment and emplacement of their experiences, leading to engagement in reflection about subjective and affective experiences (Vannini 2015, Boyd & Edwardes 2019, von Benzon et al. 2021). Following this methodological tradition, we organized performative workshops in which the research participants were invited to experience the *Origenes botanica* narrative and to engage in a creative mapping session.

The workshops followed a three-step protocol that was conducted on the same day. First, participants were asked to undertake the *Origenes botanica* experience individually. This entailed being guided throughout the garden while reading the story in the app until they reached the end of the narrative, which every participant was able to achieve in an average of 15 minutes. Secondly, after a half-hour coffee break, participants took part in a two-hour creative mapping session in groups of 6 or 7 individuals, which was conducted in a building belonging to the Jardim Botânico da Ajuda. Participants were given an orthophoto map of the botanical garden in an A4 paper sheet and asked to draw the trajectory that they undertook during the experience and the species they encountered (Fig. 2). The purpose of this task was to allow participants to recall their experience in a structured way. After drawing their trajectory, they were invited to present their experience to the group while they transposed their trajectory to a shared map on an A3 paper sheet (Fig. 3). Thirdly, participants were asked to identify the main emotions they felt during the experience. For this task, they were given a vocabulary of emotions based on the Portuguese version of PANAS (Galinha & Pais-Ribeiro 2005), which included main categories and alternative adjectives, to facilitate self-expression. After this, participants were invited to place their emotions in the shared map, and we undertook a group discussion of their emotions and their relation to nature connectedness and environmental responsibility. The group discussion was strategic to facilitate a deeper discussion of the experience of the walk through the garden, the encounters with the species, and the emotions that emerged as partici-

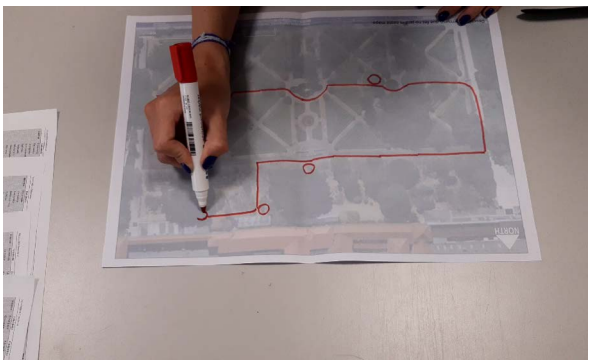

Fig. 2: Creative mapping workshops. Participants are drawing the trajectories of their experience and the places where they stopped to look for species.

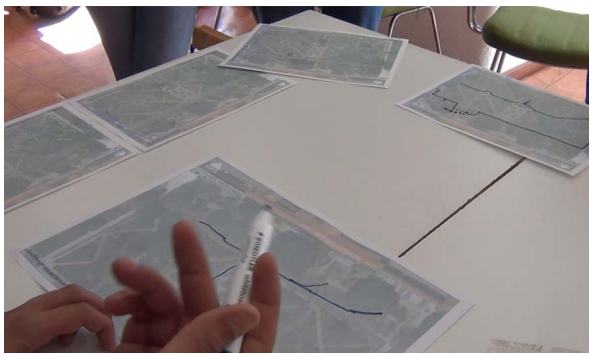

Fig. 3: Creative mapping workshops. Participants are transposing their walking trajectories from their personal A4 pages to a collective A3 page, while verbally describing their emotional experience during the walk.

pants were able to share their experiences and confront differing perspective. The methodology of this study followed the ethical assessment procedures of the corresponding author's institute.

The workshops took place during Saturday morning in the months of March and May 2022. We held the workshops during Saturday mornings to ensure that participants had no school or work attendance. We did so to minimize work- and school-related stress and to avoid peak hours of the botanical garden. The weather was clear during every workshop and outside temperatures ranged between 17 and 25 degrees Celsius. There were no other events taking place at the botanic garden during the workshops and there were no more than 4 other visitors at the garden at any given time, which allowed the participants to engage in the experience without obstruction or nuisance.

For these workshops, we recruited a group of 19 participants through an open call through the social media of the institution that manages the Jardim Botânico da Ajuda. The sole elimination factor was that participants must be visiting the botanical garden for the first time. The purpose was to ensure that the study approaches the experience of a visitor of the garden, and to guarantee that participants had similar levels of engagement with the garden. Participants were selected on a first come, first served basis. All the participants are of Portuguese nationality and white ethnicity, and their age ranges from 19 to 36 years old. 10 participants were men and 9 were woman. Education ranges from secondary to tertiary education. In this sense, the sample of participants represents the perspective of young and educated individuals, and therefore cannot account for ethnic, education, or age diversity. The recruitment of younger participants is due to the fact that the *Origenes botanica* narrative was develop with a young target audience in mind.

The workshops were recorded in video format. Audio was later transcribed to text and codified under the categories of: treasure hunting and reward systems; direction of attention; emotional and sensory contact with the environment; and environmental responsibility. The information gathered during the workshops allowed us to understand how the game techniques of Origenes Botanica provided an immersive and engaging experience in which ambiguous feelings have led participants to critically reflect on their own nature connectedness and environmental responsibility. We explore these results in the next sections.

4 The experience of *Origenes botanica*

Origenes botanica is an urban nature experience that incorporates two gamification techniques, namely treasure hunting and a reward system. Here, we explore how these gamification techniques have led to an engaging and immersive nature experience. First, we show how treasure hunting directed the attention of participants and stimulated sensory contact and appreciation of beauty among the participants, thereby enhancing nature connectedness. Secondly, we demonstrate how the reward system motivated participants and promoted environmental responsibility by emphasizing conservation issues.

4.1 Encouraging sensory contact and appreciation of beauty

Feelings related to nature connectedness were widely mentioned by the participants, mostly in relation to the aesthetic experience of sensory contact and appreciation of beauty while wandering through

the garden looking for plant species. Participants highlighted the dimension of exploration created by the treasure hunting dynamic. More precisely, participants reported that although they often felt confused and lost during the experience, these feelings also led them to be more attentive to the natural features of the garden.

The landscape and ambiance of the garden itself was commonly mentioned by the participants as the first feature of the garden which they perceived, as participant 2 mentioned:

> [P2] I went straight ahead at the beginning. I went around here [pointing to the map], looking at everything, everything that was around me. I was also looking at the landscape, the Tagus river, but whatever. I was reading the story, on the app. I stopped here [pointing]. Then, I started looking for the tree, the first one.

The participants generally mentioned that the treasure hunt led them to pay attention to the landscape of the garden first in order to find spatial reference points that could be useful for the hunt, which is in line with the argument that treasure hunting as a gamification technique is useful for leading users to follow specific paths and guiding them to focus on specific nuances of that path (Bulencer & Egger 2015). While doing so, participants also noticed the pleasantness of the ambiance of the garden. It is relevant that *Origenes botanica* draws attention to ambiance as it has been widely recognized that ambiance is a crucial element of nature experiences since it is related to the sense of relaxation and effortless attention that natural sites might provide, and which might promote attention restoration (Williams 2017, Biglin 2020, Dobson et al. 2021). While there might be concerns that the mediation of game techniques interfaces minimizes direct contact with nature (Soga & Gaston 2016, Soga et al. 2016, Cleary et al. 2020), the treasure hunting technique in this case seems to have promoted this atmospheric form of contact with nature. Indeed, some participants related that their appreciation of the ambiance was driven by the visual storytelling of *Origenes botanica* which depicts the garden in a colourful manner, as Participant 1 mentioned:

> [P1] I was happy and joyful because the ambiance of the garden is very pleasant. And the weather was great. I was joyful because the app has a very cute interface. I was also excited because of that. At the same time, I was a bit confused in those sectors in which I had some trouble finding the species.

Although it is apparent that the treasure hunt directed attention toward the garden's ambiance at the beginning of the experience, it should be acknowledged that this ambiance could have also be noticed by participants in a visit to the garden not mediated by an app. However, as participants needed to identify specific species, the visual storytelling of the treasure hunt also directed their attention to more specific sensory features that could otherwise go unnoticed. When looking for plant species, participants focused mostly on specific sensory features that were described visually in the narrative, rather than the written descriptions of the species. The colour, shape and diversity of the plants were the most highlighted elements. For instance, Participant 3 discussed how their search for Jacaranda mimosifolia D. Don was guided by the search for a purple leaf:

> [P3] - I went up here [pointing]. I saw it, I don't know, I am not sure. That plant with purple stuff, purple leaves, I am not sure if…
> [Researcher] - The Jacarandá?
> [P3] - I am not sure. That was a bush. That I know of, Jacarandá is a tree.
> [Researcher] - Yes, if you were looking at a bush, then you saw the wrong plant.
> [P3] - But then when I was up here [pointing], where all the plants are. And since there were some trees without leaves, I could not tell them apart.

On the other hand, Participant 5's search for the trees was mostly guided by the shapes of the treetops, branches, and leaves:

> [P5] I think the first point was here [pointing]. It was an Araucaria. It was a tall one, the branches were dispersed. I think the second one was this one down here [pointing]. It was short, but very wide. Then, since the third point was the Jacaranda, which I associated with purple leaves. I came around and crossed this part here. Then I realized that those were bushes and Jacaranda was a tree, so I went up and stopped here [pointing]. Then I saw it.

The participants' focus on the sensory features of plants also led them to become lost. For instance, Participant 4 searched for the *Ginkgo biloba* L. by

looking for a tree with leaves shaped like the ones in the visual narrative but ignored a statement by one of the characters that mentioned that the tree was deciduous. As the experience took place in May and the tree had lost its foliage, Participant 4 had difficulty in finding the tree, as they explain:

> [P4] I felt drifting away and frustrated when I got lost looking for the *Ginkgo biloba*. I felt completely lost. And I got frustrated for how long it took me to get there. But I was also becoming enchanted and cheered up by the experience. The general experience and what the garden has to offer to people. The diversity of trees, plants, which is unusual.

In this sense, the treasure hunt led participants to enter a specific state of attention to the sensory features of plants, both at the wider level of landscape and ambiance and the more specific level of the colour and shape of each species. Visual attention was frequently mentioned, which can be related to the way in which the *Origenes botanica* narrative describes the plants. This echoes the notion that people's connection to nature stems from their sensory contact, rather than from objective evaluations of biodiversity (Voigt & Wurster 2015, Clayton et al. 2017, Shwartz 2017). Indeed, most participants reported that, over the course of the experience, they felt a connection to the natural features of the garden, one that was most often described as an emerging sense of peacefulness. Although attention to plants seems to have been mostly visual, this sense of peacefulness seems to have been a multisensory experience, as it included appreciation of the weather, the ambiance and sound. For instance, Participant 6 highlighted the ambiance of the garden and the pleasant weather of the day:

> [P6] I was feeling excited because it was an experience that I had never had, and I had also never visited this garden. Over time, I felt peaceful, because it was a very peaceful experience. I enjoyed the experience and the garden's ambiance. It has a certain soothing effect. The view and the weather also help me to feel this peace of mind. And the walk ends up not being stressful at all. For me, at least, this brings me some peace.

On the other hand, Participant 7 highlighted the overlapping of the calmness of the garden, mentioning the tranquility of the soundscape, composed by silence and birdsong, and the pleasure of reading a story while walking. For these reasons, the participant states that they were calm during the whole experience:

> [P7] I felt peaceful during almost the whole experience because due to the ambiance but also the story. I was calm the whole time. Even when I was undecided or lost, because I went in circles a lot. The garden's ambiance has a calming effect.

Thus, as the treasure hunt dynamic led participants to focus on wandering through the garden while attuning to the sensory features of plants, it also fomented a deeper, more active connection to nature, which resulted in an emerging feeling of peacefulness, which is in line with the idea that sensory contact, emotional responses and appreciation of beauty are the main pathways to nature connectedness (Lumber et al. 2017, McEwan et al. 2020). This also indicates that gamification techniques introduced by digital media have the potential to foster more engaging and immersive multisensory and bodily engagement rather than mere passive visual observation, as other arts- and technology-based approaches have sought to do (Clayton et al. 2017, Shwartz 2017, Schuttler et al. 2018, McEwan et al. 2019, 2020). In the next section, we explore the relation of such engagement with the promotion of environmental responsibility.

4.2 Emphasizing environmental responsibilities

While *Origenes botanica*'s treasure hunt feature fostered nature connectedness, the contents of the reward system also promoted environmental responsibility. *Origenes Botanica* narrative tells a story of environmental degradation and loss but incorporates a sense of hope and urgency meant to encourage environmental responsibility. Furthermore, each time a participant finds a plant species, he or she is rewarded with an interactive map that provides information on the environmental threats that these plants are facing. In this sense, the experience incorporates a sense of local-global interactions as the in-person experience is contextualized into global processes.

Participants have mostly reported that the experience have led them to reinforce previous concerns with environmental degradation, rather than remembering new information provided by the narrative in detail. This is evident in a conversation between two participants:

> [P8] – I think most of these ideas were ideas that I already had.
> [P9] - Me too. That last environmental threat in the narrative, I was not entirely aware of the dimension of extinction being so serious, and that it might endanger the species.
> [P8] – Yes, they are ideas that are already there, but then they are reinforced.
> [P9] – But to see a specific case is helpful to contextualize this. It is complementary.
> [P8] – Then, there are people who might be against it [overcollecting], others might see no problem, so this ends up bringing up the side of reason.

Given that it was mostly existing concerns that we reinforced by the experience, participants did not associate these concerns to a specific element of the narrative. However, they frequently mentioned the character's discourses and the cartographic information which is the reward. Despite this, the reinforcement of existing concerns was mostly associated with the emotional dimension of this reward. While this supports the idea that reward systems provide an opportunity to introduce learning moments in designed experiences (Linaza et al. 2014, van Gaalen et al. 2021), it also underlines the importance of the emotional nuances, rather than the mere presentation of information. Participants expressed their concerns in terms of their negative and personal feelings for the loss of a cherished species, a loss that is it framed both as a personal and a collective loss. In the words of Participant 10:

> [P10] - Well, I am concerned, apprehensive and surprised. I am surprised because I was not… I mean, I know that there are global threats to the existence of species, but I didn't know that there were so many species and that makes me concerned and apprehensive. Since this is not my area, I was also interested not only in knowing more about the species, but also their global threats and their consequences on the species.

Here, the relation between nature connectedness and conservation action that is mentioned in the literature becomes evident (Prévot et al. 2018, Egerer et al. 2019, Pauleit et al. 2019). This relation is however mostly driven by a concatenation of contradictory feelings. The positive sensory experience of the contact with nature makes participants cherish the species, while the threat of their destruction elicits negative feelings of anxiety. Eco-anxiety, here understood as a "specific form of anxiety relating to stress or distress caused by environmental changes and our knowledge of them" (Usher et al. 2019: 1233), seems to play a significant role in the link between nature connectedness and conservation action in this nature experience, which is consistent with current knowledge on the relation between eco-anxiety and eco-friendly behavior (Mallett 2012, Bahja & Hancer 2021, Fischer & Riechers 2021). Eco-anxiety seems to be an important driver of the desire to know more about species themselves and also about the most effective types of conservation action, especially the kind that participants can engage in themselves:

> [P12] - I was feeling interested in knowing more about the species, because I felt a great deal of respect because we are dealing with an issue that, it is a matter of lack of respect. For instance, stepping on the plants. I often ask people not to step on plants, gardens are places where we need to show respect. It is a place to be worshiped and to show great respect for the type of plants, not only because they might be facing extinction, but also because it is the environment itself.

As this quote suggests, participants showed a desire to know more about the species and conservation action, which was mostly framed by a state of mind linked to environmental awareness and responsibility. This sense of responsibility was expressed by the participants mostly through a shared sense of personal and collective accountability, which itself was driven by the negative eco-anxiety feelings:

> [P11] - I think this is something that we all should fight for, because if we take the species from the place where they are, we will lose them, and we must be careful and attentive, because they are crucial. They exist for a reason, and that reason must be on the mind of everyone so that we can make sure we have a dignified future.

> [P13] - There is the concern of knowing that something can be done, that everyone knows that, and perhaps it has not been done yet. Or that we can do better.

In sum, the experience was successful in promoting a sense of environmental responsibility through the elicitation of negative feelings related to the sense

of loss of biodiversity. However, it was mostly existing concerns that were reinforced, rather than new information. Nevertheless, the gamification of urban nature experiences seems to be a promising avenue for fostering environmental awareness and willingness to participate in conservation action. The gamification of urban nature experiences not only draws on the widely acknowledged link between nature connectedness and conservation action (Lacoeuilhe et al. 2017, Prévot et al. 2018, Egerer et al. 2019, Sato et al. 2021), but it also allows designers to integrate environmental information into the experience. In this sense, the sensory experience, which the literature suggests that might be more important for nature connectedness (Pett et al. 2016, Shwartz et al. 2014), can be transformed into an educational experience as well.

5 Conclusion

In this article, we have explored the potential of gamification to co-create engaging and immersive experiences of urban nature. We have shown that gamification techniques such as treasure hunting can offer a way to direct attention in urban nature experiences and encourage sensory contact and appreciation of beauty, thus promoting nature connectedness (Voigt & Wurster 2015, Clayton et al. 2017, Lumber et al. 2017, Shwartz 2017, McEwan et al. 2020, Li & Nassauer 2021). Treasure hunting can be an important tool to lead participants to immerse themselves in the natural environment and become attentive both to the wider ambiance and the specific sensory features of plants, which are significative triggers for attention restoration and aesthetic experience, which in turn enhance nature connectedness (Williams 2017, Biglin 2020, Choe et al. 2020). In this sense, gamification techniques in nature experiences do not draw users away from direct contact with the features of nature, as it could be argued (Soga & Gaston 2016, Soga et al. 2016, Cleary et al. 2020). Indeed, we have seen that even when gamification techniques focus on a specific sense, such as vision, users still engage with the natural environment through a multisensory experience and retain significant emotional memories of those experiences.

Furthermore, we have shown that the introduction of gamification techniques such as reward systems in urban nature experiences can further promote environmental responsibility among users – a topic of importance in urban nature studies (Lacoeuilhe et al. 2017, Prévot et al. 2018, Egerer et al. 2019, Sato et al. 2021). In this sense, the gamification of nature experiences can be applied to enhance the well-known connection between nature connectedness and conservation action (Prévot et al. 2018, Egerer et al. 2019, Pauleit et al. 2019). There must however be attention to the contents of gamification techniques. While the gamification of nature experiences allows designers to integrate environmental information into the experience, such information might generate different emotional responses. Positive experiences that also elicit feelings of eco-anxiety can contribute towards a greater desire to know more about nature and lead to eco-friendly behavior by promoting a shared sense of personal and collective accountability, but we need to be aware that literature on eco-anxiety also underlines that this feeling might lead to a sense of hopelessness (Mallett 2012, Bahja & Hancer 2021, Fischer & Riechers 2021).

It has been noted that gamified systems can lead to exploitation and manipulation as users might not become aware of how the gamification techniques influence their behavior (Arora & Razavian 2021). On the contrary, the gamification techniques in Origenes botanica seemed to provoke conscious reflection among participants, as most expressed a desire to know more information about matters of conservation. In addition to this, most participants reinforced previous beliefs about nature conservation rather than highlighting new ideas immediately after the experience. This suggests that gamification in nature experiences can be helpful for triggering reflection and desire for knowledge but might be limited in terms of imposing new information, which can also be positive as it makes it harder to manipulate individuals with such techniques. Nevertheless, this also suggests that the implementation of these techniques requires proper ethical assessment before and after the creation of experience, as the results can be unexpected (Thorpe & Roper 2019).

Taking this into account, the gamification of urban nature experiences can be conceived as a viable alternative to foster contact with nature within cities, thus countering the 'extinction of experience' (Pyle 1993, Cox et al. 2017). Given that people, especially younger generations, tend to prefer sedentary indoor pastimes that involve the use of digital technologies (Soga & Gaston 2016, Soga et al. 2016, Soga et al. 2018, Cleary et al. 2020), game techniques and digital interfaces can become an attractive tool that draws more people into nature in the future. In other words, it might be a successful tool when more direct urban experiences such as agriculture, foraging, gardening, or bird-feeding fail to attract people to urban nature sites (Fischer & Kowarik 2020, Lin et al. 2018).

Further research is needed to grasp the full potential of gamification techniques and digital mediation in urban nature experiences. Although there is a growing body of literature on the application of digital tools in fostering contact with nature and conservation (Schuttler et al. 2018, McEwan et al. 2019, 2020, Radicchi 2019), there is more to know about the benefits of different kinds of digital interfaces and experiences. This implies examining a greater number of practical case studies of real-world experiments, but also comparative perspectives to understand how different techniques can be combined. Furthermore, despite the merits of ongoing research, the integration of these applications within urban design projects is quite incipient. Understanding how urban nature sites can be designed both materially and digitally is key to co-create more immersive and meaningful experiences.

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