

BotaXplore: Enhancing Visitor Engagement and Learning in Botanical Gardens Through Mobile Technology

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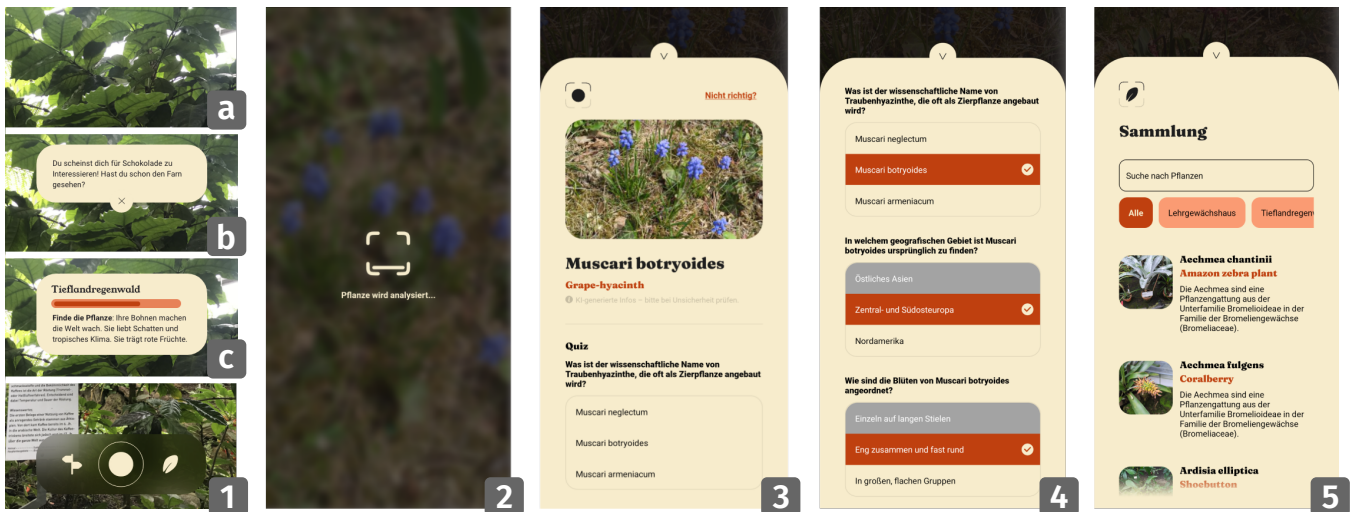


Figure 1: BotaXplore, a mobile application supporting plant exploration and learning in botanical gardens through three modes: (1a) exploratory, (1b) semi-guided, and (1c) tour-based (only banner changes). Visitors interact with plants by (1–2) scanning a plant, (3) receiving plant information, (4) answering quiz questions, and (5) browsing their collected plants.

Abstract

Educational guided visits in botanical gardens offer valuable opportunities for learning and engagement that promote awareness of the importance of biological diversity, its conservation, and sustainable use. However, a focus group with five botanists identified challenges in designing tours for heterogeneous audiences that foster curiosity and interest, as well as in tailoring educational content. To address these aspects, this paper presents BotaXplore, a prototype mobile application that supports plant exploration in botanical gardens through three modes: exploratory, semi-guided,

and tour-based. Using photo-based identification, users access short facts and quizzes about plants, and discovered species are added to a personal collection. Building on this prototype, we plan to evaluate the app's impact on nature engagement and learning outcomes after improving learning paths, content generation, and support for collaborative exploration.

CCS Concepts

• Human-centered computing → Interactive systems and tools; • Applied computing → Education.

Keywords

Self-Assessment, Behavior Change, Interaction Design, Self-Efficacy, Sustainability

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1 Introduction

Raising environmental awareness is a central public interest, particularly as biodiversity loss accelerates and public understanding of ecosystems becomes increasingly important [28]. Alongside formal schooling, institutions such as botanical gardens and educational greenhouses play an important role in this effort by providing in-situ encounters [2, 33] with threatened plant species and by communicating their ecological importance.

Settings where traditional guided tours with a human guide are offered can elicit momentary engagement, however, educators in such contexts often have limited means to personalize explanations to heterogeneous audiences (e.g., diverse age groups), assess what visitors take away, or support learning beyond the visit [1]. While plant identification apps are widely available (e.g., iNaturalist [14]), they are typically designed for general-purpose use and offer limited site-specific contextualization [11, 23]. In addition, these tools rarely allow educators to author or adapt content to align with local tour narratives and learning objectives. As a result, guided tours frequently rely on generic materials and offer limited support for revisiting content, which can constrain sustained interest and follow-up learning.

To address these aspects, we built BotaXplore. BotaXplore is a mobile Android application that supports plant exploration through photo-based identification, on-the-fly generation of concise educational content including quizzes, and three levels of guidance (*Exploratory*, *Semi-Guided*, and *Tour Mode*) that accommodate different visitors' preferences. The system additionally supports continued engagement by maintaining a personal collection of scanned plants. To develop BotaXplore, we initially conducted an expert focus group with five staff members responsible for the educational curriculum and tours at our institution's botanical garden and greenhouses. The focus group revealed challenges encountered during tours and expectations for an interactive mobile learning system, given contemporary capabilities in computer vision and generative technologies.

In this work, we describe the design rationale for BotaXplore based on our collaboration with educators at our botanical institute, present the current prototype and its key interaction mechanisms, and outline planned deployments within the institute's educational facilities. We also discuss how these deployments will examine integration into guided and self-directed visits, and how the system may support learning and sustained engagement beyond the on-site experience.

2 Related Work

2.1 Nature Engagement Through Technology

Prior HCI research has examined how interactive systems can support various forms of nature engagement and environmental awareness [31]. This work includes technologies that help individuals observe (e.g., [8, 30]), interpret (e.g., [27]), and interact with natural environments (e.g., [34]). In their recent literature review Webber

et al. [31] report that most prior work proposing technology as a medium for interacting with nature can be aligned along the axes of distance and directness. Here, directness denotes the degree of interaction with nature and ranges from direct, real interactions to indirect representations enabled by technology [31]. This can be achieved through sensing and data capture that makes non-human activity more legible and personally meaningful [24, 31]. Among existing plant and nature exploration applications *iNaturalist* [14] is one of the most popular platforms that use citizen science and social learning. It enables observers to make observations about living things, receive species recommendations through image identification, and narrow down identifications via community feedback. The platform also incorporates gamification elements, such as observation counts, leaderboards, and progress tracking, which have been shown to positively impact user engagement and curiosity [22]. While platforms such as *iNaturalist* support open-ended discovery and user contributions, they do not embed pedagogically structured frameworks. Instead, they can primarily be used as informational dashboards. Educational content is largely determined by what a user encounters, and educators have limited ability to personalize or sequence learning content toward specific objectives. Incorporating these capabilities in ways that foster curiosity and sustained engagement remains challenging, as prior work cautions that poorly integrated technology can distract from, or diminish, nature experiences [24, 31]. Accordingly, designs should preserve and extend attention to the environment rather than shifting it to the device [4, 6, 15].

2.2 Technology-supported Learning

Prior work in technology-mediated learning has long leveraged everyday devices such as smartphones, tablets, and laptops [18]. Mobile systems, in particular, have been used to support learning in the moment by providing contextual explanations and interactions at the point of encounter [13]. This has proven effective for contexts beyond the classroom, such as museums [26], field trips [16], and other public environments [12]. More recently, immersive learning approaches in augmented and virtual reality have aimed to deepen experiential understanding by embedding instructional overlays, spatial cues, and interactive simulations into learners' environments (e.g., [10, 20]).

Across these technologies, previous studies have established that features such as quizzes, achievements, and task-based progression, for example, scavenger-hunt-style activities, can improve intrinsic motivation and knowledge retention [3, 5]. These mechanisms encourage learning of personally meaningful interests [9]. Recent advances in natural language processing, particularly large language models (LLMs), broaden these opportunities by enabling on-demand generation of instructional content, questions, feedback, and prompts tailored to learning goals [17, 19, 21]. Prior systems also illustrate the benefits of AI-mediated quizzing and conversational support for learning and self-regulation [25, 32].

3 Design Rationale

3.1 Expert Focus Group

Prior research on technology-mediated learning proposes mechanisms such as gamification [29], adaptive question sequencing

[25], and visual highlighting [7] to support learning and stimulate curiosity. However, it remains unclear to what extent these approaches are currently adopted in informal educational settings, how educators perceive their effects in practice, and where their limitations lie. To investigate these aspects, we conducted a focus group with staff from the Institute of Botany at our institution ($N = 5$). The Institute of Botany offers guided educational tours in its greenhouses and botanical garden, aiming to raise awareness of endangered plant species and their roles within broader ecosystems. Participants included two botanical researchers and three horticulturists who collectively design and deliver educational programs for students and external visitors. Three participants self-identified as male and two as female. In terms of age, one participant specified to be between 18 and 29, and the remaining specified 40 and 59. The session began with a brief overview of technology-supported learning mechanisms found in prior work (see Section 2.2). Participants were then asked to (1) describe their roles in the institution's educational activities, (2) how they currently use technology in these contexts, and (3) what limitations they perceive. One author documented responses during the session and requested clarifications as needed. The focus group lasted approximately one hour.

3.2 Results

The documented responses were inductively coded by one author and then clustered into *themes* (T).

T1 Designing Tours That Foster Curiosity for Everybody Is Challenging. Participants described substantial difficulty in designing tours that reliably foster curiosity across heterogeneous visitor groups. Differences in age, prior knowledge, interests, and motivations required educators to continuously improvise during tours, often prioritizing breadth over depth. While interactive elements and storytelling were perceived as effective for engaging some audiences, participants noted that these approaches could be off-putting for others who preferred factual or self-directed exploration. As a result, tours were frequently designed around the minimum content that could be interesting to the largest audience.

T2 Uncertainty About Lasting Impact on Interest Beyond the Tour. Educators expressed uncertainty about whether tours successfully sparked sustained interest beyond the immediate experience. Although visitors often appeared engaged during tours, participants lacked mechanisms to assess longer-term outcomes such as follow-up learning, changes in attitudes toward plant conservation, or subsequent information-seeking behavior. This absence of feedback made it difficult to evaluate the effectiveness of specific pedagogical strategies or to iteratively improve tour design based on evidence of impact.

T3 Customizing Education Material. Participants reported that authoring and maintaining educational materials was time-intensive and largely manual. Content creation relied heavily on individual expertise, with limited support for reusing, adapting, or personalizing materials across audiences. While participants already used existing tools such as iNaturalist to support species identification and engagement, these tools were described as insufficient for structured educational goals, as they offer limited control over content

framing, pedagogical sequencing, and alignment with tour narratives. Balancing scientific accuracy with accessibility remained a persistent challenge.

3.3 Design Goals

Based on our focus group findings, we derived the following high-level *design goals* (DG) to guide system implementation.

DG1 Personalization and Content Generation. Support educators' need to address heterogeneous audiences by dynamically generating plant-specific learning content and lightweight assessments that adapt to individual exploration and enable reflection on learning progress (addressing $T1+3$).

DG2 Flexible Guidance Modes. Provide flexible levels of guidance that scaffold exploration without constraining autonomy. In particular, facilitate following structured routes, receiving contextual recommendations, or completely free exploration according to visitors' personal preferences (addressing $T1$).

DG3 Collecting Artifacts. Encourage sustained engagement beyond the tour by enabling visitors to collect, revisit, and reflect on the plants they encounter (addressing $T2+3$).

4 BotaXplore

BotaXplore is an Android application for exploring and learning about plants while visiting educational facilities such as greenhouses or botanical gardens. Upon launching the app, users can take a photo of a plant they want to explore (see Fig. 1 (1)). The app analyzes the image using the PlantNet API¹ and matches the result against a Firebase database containing only plants present in the botanical garden (see Fig. 1 (2)). This database can be edited by educators to restrict results to the local collection. In doing so, BotaXplore supports in-situ exploration with fewer irrelevant matches and facilitates discovery during guided or self-directed visits ($DG2$).

Once a plant is identified, its Wikipedia summary is retrieved, from which key facts are presented to the user. To generate plant-specific quizzes, GPT-4o mini² is prompted with Wikipedia-retrieved information, grounding the model's response in community-curated and plant-specific content (see Fig. 1 (3–4)). This directly supports *DG1 Personalization and Content Generation* by providing concise educational content that adapts to a user's individual exploration history and enables reflection on learning progress through repeated quizzes across encountered plants. All scanned plants are automatically stored in a personal collection that users can browse and filter. This enables reflection during or after the visit (see Fig. 1 (5)). With this feature, we operationalize *DG3 Collecting Artifacts* by turning plant encounters into persistent artifacts that can be revisited beyond the tour.

To accommodate different information-seeking styles, BotaXplore provides three guidance modes in line with *DG2*. *Tour Mode* supports structured routes through progress indicators and contextual hints that guide users along a predefined path. This path can be set by educators themselves. *Semi-Guided Mode* offers contextual recommendations by suggesting related plants based on previously scanned species. This mode balances exploration while preserving

¹PlantNet API, accessed 22.01.2026

²OpenAI API GPT-4o mini, accessed 25.02.2026

autonomy, similar to hybrid interaction modes proposed in prior technology-mediated Human-Nature concepts in HCI (e.g., [34]). *Exploratory Mode* supports completely free exploration by allowing users to scan any plant without guidance on what to engage with next. Across modes, facts and quizzes provide plant-specific content and assessment (DG1), while automatic collection preserves artifacts for later revisiting (DG3).

5 Initial User Evaluation

We conducted an initial in-situ user evaluation to investigate which guidance mode promotes engagement and to gather feedback on the current set of features in BotaXplore. Ten participants used the app during a visit to the botanical garden's three public greenhouses. Of the participants, seven selected 'man' as the label that best described their gender identity, two selected 'woman', and one preferred not to disclose. The mean age was 26 years ($min = 21$, $max = 51$, $SD = 8.42$). Seven participants were students, two were employed, and one was unemployed. They were first assigned one of a specific guidance mode (*Tour*, *Semi-Guided*, or *Exploratory*) and then asked to explore three educational greenhouses using the app. This included scanning plants of interest and engaging with the provided facts and quizzes during the visit. Afterward, participants completed a short questionnaire focused on usability and provided open-ended comments. We also recorded brief observations and participant remarks during use.

5.1 Measures

Participants' *engagement* was assessed by collecting *number of photos* taken and *time spent* in the botanical garden (i.e., time difference between first and last photo taken). To gather feedback on BotaXplore, we asked for qualitative feedback on their experience, perceived usability, and suggestions for improvement after their visit.

5.2 Findings

Engagement. Participants engaged with the app throughout their greenhouse visit. Participants in *Exploratory* ($M = 47.75$ minutes) and *Tour Mode* ($M = 46.33$ minutes) spent similar time on-site, while *Semi-Guided* users spent less time overall ($M = 29.33$ minutes). Plant scanning activity showed a similar pattern, with participants in *Exploratory* ($M = 23.25$) and *Tour Mode* ($M = 23.00$) scanning more plants on average than *Semi-Guided* users ($M = 11.67$).

Qualitative Feedback. Across conditions, participants frequently described the interface as visually clear and "minimalistic" or "clean", and several highlighted that scanning plants was intuitive to use and receiving immediate feedback felt engaging during the visit. In addition to these positive impressions, participants offered concrete suggestions for refinement in the next iteration. These included providing more precise hints when users are searching for specific plants, offering optional cues when quiz items feel difficult, and improving the clarity of a small number of navigation elements to make progression more self-explanatory.

6 Conclusion and Future Work

In this poster, we presented BotaXplore, a work-in-progress mobile application for supporting plant exploration and learning in botanical greenhouses. Grounded in educator input, BotaXplore integrates plant-specific learning with quizzes (DG1), multiple guidance modes for different visiting styles (DG2), and a personal collection to enable revisiting encountered plants beyond the visit (DG3). An initial in-situ user evaluation suggests high perceived usability of BotaXplore and active engagement with both fully-guided and exploratory modes. The present insights provide actionable guidance for subsequent design iterations and suggest that effects of BotaXplore on engagement warrant further empirical evaluation. Building on the current prototype, we will extend BotaXplore with adaptive learning paths (i.e., learning content that adjust dynamically based on a learner's progress, performance, and prior knowledge) and optional real-time multiplayer features to support collaborative exploration. We will also refine the challenge structure in *Tour* and *Semi-Guided* modes by simplifying tasks and improving the specificity and timing of hints. To further support sustained engagement, we plan to add progression mechanics, such as achievements, milestones, and personalized badges, to make progress visible. Finally, we will evaluate these additions through a larger field deployment in collaboration with our botanical institute to assess in-situ use, learning performance, and engagement beyond the visit.

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References

- [1] Liliana Ardissono, Tsvi Kuflik, and Daniela Petrelli. 2012. Personalization in cultural heritage: the road travelled and the one ahead. *User modeling and user-adapted interaction* 22, 1 (2012), 73–99.
- [2] Roy Ballantyne, Jan Packer, and Karen Hughes. 2008. Environmental awareness, interests and motives of botanic gardens visitors: Implications for interpretive practice. *Tourism management* 29, 3 (2008), 439–444.
- [3] Gabriel Barata, Sandra Gama, Joaquim Jorge, and Daniel Gonçalves. 2013. Improving participation and learning with gamification. In *Proceedings of the First International Conference on gameful design, research, and applications*. 10–17.
- [4] Nicola J. Bidwell and David Browning. 2010-01-01. Pursuing Genius Loci: Interaction Design and Natural Places. *Personal and Ubiquitous Computing* 14, 1 (2010-01-01), 15–30. doi:10.1007/s00779-009-0217-8
- [5] Robin Brewer, Lisa Anthony, Quincy Brown, Germaine Irwin, Jaye Nias, and Berthel Tate. 2013. Using gamification to motivate children to complete empirical studies in lab environments. In *Proceedings of the 12th international conference on interaction design and children*. 388–391.
- [6] Bronwyn J. Cumbo and Ole Sejer Iversen. 2020. CCI in the wild: designing for environmental stewardship through children's nature-play. In *Proceedings of the Interaction Design and Children Conference* (London, United Kingdom) (IDC '20). Association for Computing Machinery, New York, NY, USA, 335–348. doi:10.1145/3392063.3394398
- [7] Tobias Drey, Patrick Albus, Simon der Kinderen, Maximilian Milo, Thilo Segsneider, Linda Chanzab, Michael Rietzler, Tina Seufert, and Enrico Rukzio. 2022. Towards Collaborative Learning in Virtual Reality: A Comparison of Co-located Symmetric and Asymmetric Pair-Learning. In *Proceedings of the 2022 CHI Conference on Human Factors in Computing Systems* (CHI '22). ACM, New York, NY, USA, 1–19. doi:10.1145/3491102.3517641
- [8] William Gaver, Andy Boucher, Michail Vanis, Andy Sheen, Dean Brown, Liliana Ovalle, Naho Matsuda, Amina Abbas-Nazari, and Robert Phillips. 2019. My naturewatch camera: Disseminating practice research with a cheap and easy DIY design. In *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems*. 1–13.

- [9] Russell Golman, David Hagmann, and George Loewenstein. 2017. Information avoidance. *Journal of economic literature* 55, 1 (2017), 96–135.
- [10] Aditya Gunturu, Yi Wen, Nandi Zhang, Jarin Thundathil, Rubaiat Habib Kazi, and Ryo Suzuki. 2024. Augmented Physics: Creating Interactive and Embedded Physics Simulations from Static Textbook Diagrams. In *Proceedings of the 37th Annual ACM Symposium on User Interface Software and Technology (UIST '24)*. Association for Computing Machinery, New York, NY, USA, 1–12. doi:10.1145/3654777.3676392
- [11] Adam G. Hart, Hayley Bosley, Chloe Hooper, Jessica Perry, Joel Sellors-Moore, Oliver Moore, and Anne E. Goodenough. 2023. Assessing the accuracy of free automated plant identification applications. *People and Nature* 5, 3 (2023), 929–937. doi:10.1002/pan3.10460
- [12] Ari Hautasaari, Takeo Hamada, Kuntaro Ishiyama, and Shogo Fukushima. 2020. VocaBura: A Method for Supporting Second Language Vocabulary Learning While Walking. *Proc. ACM Interact. Mob. Wearable Ubiquitous Technol.* 3, 4 (Sept. 2020), 135:1–135:23. doi:10.1145/3369824
- [13] Tomi Heimonen, Markku Turunen, Sanna Kangas, Tamás Pallos, Pasi Pekkala, Santeri Saarinen, Katariina Tiitinen, Tuuli Keskinen, Matti Luhtala, Olli Koskinen, Jussi Okkonen, and Roope Raisamo. 2013. Seek'N'Share: A Platform for Location-Based Collaborative Mobile Learning. In *Proceedings of the 12th International Conference on Mobile and Ubiquitous Multimedia (MUM '13)*. Association for Computing Machinery, New York, NY, USA, 1–4. doi:10.1145/2541831.2541872
- [14] iNaturalist. 2026. *iNaturalist*. Retrieved 22 January, 2026 from <https://www.inaturalist.org/>
- [15] Simon L Jones and Ryan Kelly. 2018. Dealing with information overload in multifaceted personal informatics systems. *Human-Computer Interaction* 33, 1 (2018), 1–48.
- [16] Amy M. Kamarainen, Shari Metcalf, Tina Grotzer, Allison Browne, Diana Mazzuca, M. Shane Tutwiler, and Chris Dede. 2013. EcoMOBILE: Integrating Augmented Reality and Probeware with Environmental Education Field Trips. *Computers & Education* 68 (Oct. 2013), 545–556. doi:10.1016/j.compedu.2013.02.018
- [17] Enkelejda Kasneci, Kathrin Sessler, Stefan Küchemann, Maria Bannert, Daryna Dementieva, Frank Fischer, Urs Gasser, Georg Groh, Stephan Günemann, Eyke Hüllermeier, Stepha Krusche, Gitta Kutyniok, Tilman Michaeli, Claudia Nerdel, Jürgen Pfeffer, Oleksandra Poquet, Michael Sailer, Albrecht Schmidt, Tina Seidel, Matthias Stadler, Jochen Weller, Jochen Kuhn, and Gjergji Kasneci. 2023. ChatGPT for Good? On Opportunities and Challenges of Large Language Models for Education. *Learning and Individual Differences* 103 (April 2023), 102274. doi:10.1016/j.lindif.2023.102274
- [18] Jennifer W. M. Lai and Matt Bower. 2019. How Is the Use of Technology in Education Evaluated? A Systematic Review. *Computers & Education* 133 (May 2019), 27–42. doi:10.1016/j.compedu.2019.01.010
- [19] Yoonjoo Lee, Tae Soo Kim, Sungdong Kim, Yohan Yun, and Juho Kim. 2023. DAPIE: Interactive Step-by-Step Explanatory Dialogues to Answer Children's Why and How Questions. In *Proceedings of the 2023 CHI Conference on Human Factors in Computing Systems (CHI '23)*. Association for Computing Machinery, New York, NY, USA, 1–22. doi:10.1145/3544548.3581369
- [20] Chang Liu, Felicia Fang-Yi Tan, Shengdong Zhao, Abhiram Kanneganti, Gosavi Arundhati Tushar, and Eng Tat Khoo. 2024. Facilitating Virtual Reality Integration in Medical Education: A Case Study of Acceptability and Learning Impact in Childbirth Delivery Training. In *Proceedings of the 2024 CHI Conference on Human Factors in Computing Systems (CHI '24)*. Association for Computing Machinery, New York, NY, USA, 1–14. doi:10.1145/3613904.3642100
- [21] Xinyi Lu, Simin Fan, Jessica Houghton, Lu Wang, and Xu Wang. 2023. ReadingQuizMaker: A Human-NLP Collaborative System That Supports Instructors to Design High-Quality Reading Quiz Questions. In *Proceedings of the 2023 CHI Conference on Human Factors in Computing Systems (CHI '23)*. Association for Computing Machinery, New York, NY, USA, 1–18. doi:10.1145/3544548.3580957
- [22] Angela Mech, Derek Rosenberger, Philip Fanning, John J Riggins, Brian Aukema, and Jess Hartshorn. 2022. There's an app for that: Teaching entomology in the online age. *Natural Sciences Education* 51, 2 (2022), e20081.
- [23] Thomas Mesaglio and Corey T Callaghan. 2021. An overview of the history, current contributions and future outlook of iNaturalist in Australia. *Wildlife Research* 48, 4 (2021), 289–303.
- [24] Shannon Rodgers, Bernd Ploderer, and Margot Brereton. 2020. HCI in the Garden: Current Trends and Future Directions. In *Proceedings of the 31st Australian Conference on Human-Computer-Interaction (Fremantle, WA, Australia) (OzCHI '19)*. Association for Computing Machinery, New York, NY, USA, 381–386. doi:10.1145/3369457.3369498
- [25] Sherry Ruan, Liwei Jiang, Justin Xu, Bryce Joe-Kun Tham, Zhengneng Qiu, Yeshuang Zhu, Elizabeth L. Murnane, Emma Brunskill, and James A. Landay. 2019. QuizBot: A Dialogue-based Adaptive Learning System for Factual Knowledge. In *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems (CHI '19)*. Association for Computing Machinery, New York, NY, USA, 1–13. doi:10.1145/3290605.3300587
- [26] Irene Rubino, Claudia Barberis, Jetmir Xhembulla, and Giovanni Malnati. 2015. Integrating a Location-Based Mobile Game in the Museum Visit: Evaluating Visitors' Behaviour and Learning. *J. Comput. Cult. Herit.* 8, 3 (May 2015), 15:1–15:18. doi:10.1145/2724723
- [27] Alessandro Soro, Margot Brereton, Tshering Dema, Jessica L. Oliver, Min Zhen Chai, and Aloha May Hufana Ambe. 2018. The Ambient Birdhouse: An IoT Device to Discover Birds and Engage with Nature. In *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems (Montreal QC, Canada) (CHI '18)*. Association for Computing Machinery, New York, NY, USA, 1–13. doi:10.1145/3173574.3173971
- [28] Sebastian Stroud, Mark Fennell, Jonathan Mitchley, Susannah Lydon, Julie Peacock, and Karen L Bacon. 2022. The botanical education extinction and the fall of plant awareness. *Ecology and Evolution* 12, 7 (2022), e9019.
- [29] C-H. Su and C-H. Cheng. 2015. A Mobile Gamification Learning System for Improving the Learning Motivation and Achievements. *Journal of Computer Assisted Learning* 31, 3 (2015), 268–286. doi:10.1111/jcal.12088
- [30] Kellie Vella, Bernd Ploderer, and Margot Brereton. 2021. Human-Nature Relations in Urban Gardens: Explorations with Camera Traps. In *Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems (Yokohama, Japan) (CHI '21)*. Association for Computing Machinery, New York, NY, USA, Article 566, 13 pages. doi:10.1145/3411764.3445438
- [31] Sarah Webber, Ryan M. Kelly, Greg Wadley, and Wally Smith. 2023. Engaging with Nature through Technology: A Scoping Review of HCI Research. In *Proceedings of the 2023 CHI Conference on Human Factors in Computing Systems (Hamburg, Germany) (CHI '23)*. Association for Computing Machinery, New York, NY, USA, Article 521, 18 pages. doi:10.1145/3544548.3581534
- [32] Rainer Winkler, Sebastian Hobert, Antti Salovaara, Matthias Söllner, and Jan Marco Leimeister. 2020. Sara, the Lecturer: Improving Learning in Online Education with a Scaffolding-Based Conversational Agent. In *Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems (CHI '20)*. Association for Computing Machinery, New York, NY, USA, 1–14. doi:10.1145/3313831.3376781
- [33] Ivana Zelenika, Tara Moreau, Oliver Lane, and Jiaying Zhao. 2018. Sustainability education in a botanical garden promotes environmental knowledge, attitudes and willingness to act. *Environmental education research* 24, 11 (2018), 1581–1596.
- [34] Albin Zeqiri, Julian Britten, Clara Schramm, Pascal Jansen, Michael Rietzler, and Enrico Rukzio. 2025. PlantPal: Leveraging Precision Agriculture Robots to Facilitate Remote Engagement in Urban Gardening. In *Proceedings of the 2025 CHI Conference on Human Factors in Computing Systems (CHI '25)*. Association for Computing Machinery, New York, NY, USA, Article 436, 21 pages. doi:10.1145/3706598.3713180