

Conversing with Animal Avatars in Emulated Interactions at the Zoo

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Fig. 1. Illustration of an emulated interaction at the zoo. Participants discover zoo animals (left) and then chat with their animal avatar counterparts (right). We expand on Webber et al.'s interaction typology [57] to describe emulated forms of interaction enabled by novel technologies, such as large language models.

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Zoos aim to provide engaging learning experiences for visitors while supporting conservation efforts. A common challenge in zoos is providing educational information in an engaging manner to diverse target audiences. We examine how emulated interactions with animal avatars, powered by large language models, can be designed to support visitor engagement at zoos. We present *Zoodex*, a mobile application that allows zoo visitors to discover animals and ‘chat’ with digital avatars representing zoo animals. We evaluated *Zoodex* through an in-situ study with twenty participants aged 12–14. Our findings indicate that the application facilitates engagement with zoo exhibits and social interactions among teenagers. We reflect on the use of emulated interaction to support experiences that bridge the analogue and digital worlds and discuss considerations for representing animals through conversational AI.

CCS Concepts: • **Human-centered computing** → **Empirical studies in HCI**; **Natural language interfaces**; **Mobile phones**.

Additional Key Words and Phrases: Human-animal interaction; Zoos; Emulated interaction

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1 Introduction

Emerging technologies are opening up new possibilities for interaction in cultural and educational contexts [27]. Recently, the University of Cambridge’s Museum of Zoology introduced generative AI-powered avatars of animals on display, such as a preserved cockroach, enabling visitors to ‘talk’ with these [39]. Beyond museums, zoos also make use of novel technologies, serving as spaces for entertainment and education [8] while also contributing to conservation efforts for endangered species [3]. Human activities have driven many species to the brink of extinction, with some now surviving only within the confines of zoos and wildlife reserves [4, 12, 59]. Educating visitors about animals and the threats they face is one way zoos seek to promote conservation awareness and pro-environmental behaviour [18]. In mediating knowledge about animals and their habitats, zoos traditionally employ static technologies (e.g., information boards, signs, and illustrations) throughout their parks [40]. To fulfil their role of offering visitors both information and entertainment, often referred to as *infotainment*, zoos are increasingly introducing interactive technologies to enhance visitors’ experiences [55]. In today’s age of ubiquitous mobile technology, there is an opportunity to explore novel ways of engaging audiences in zoos. With their capacity for interactive and personalised content, mobile devices offer the potential to transform passive learning experiences into active, engaging encounters.

We aim to investigate how emerging technologies can be designed to enhance the infotainment value of zoo visits, particularly for teenagers—a demographic whose engagement with zoos tends to decline during adolescence. By integrating these technologies into zoo environments, it is possible to create experiences that both inform and inspire action [40]. Prior work suggests that interactive technologies can support visitor engagement with conservation messaging [55] and that a sense of connection to animals correlates with pro-environmental behaviours [18], though how technology might foster such connections remains underexplored. Webber et al. [57] highlight how interactive technologies can facilitate engagement not only with nature itself but also with elements within natural environments, such as animals, extending beyond traditional forms of engagement enabled through technology. They suggest that such engagement be categorised based on directness and distance. We extend this framework by introducing the concept of *emulated interactions*, enabling users to ‘talk’ with responsive, large language model (LLM)-powered avatars that represent real-world zoo animals. This approach employs anthropomorphism, attributing

human-like qualities, such as speech and personality, to animals to engage visitors and convey information about the animals and the conservation challenges they face. Anthropomorphism can increase empathy and interest in animals [41], but also carries risks: it may distort understanding of natural behaviours or create misleading impressions of species [19]. To mitigate potential adverse effects, anthropomorphisation must be applied thoughtfully, emphasising traits that animals genuinely possess and that visitors can observe first-hand [41]. Building on prior work on technology in zoos and recent developments in LLMs, we investigate how emulated interactions with animal avatars influence visitors' experiences and engagement.

In collaboration with *Aalborg Zoo*, we designed and evaluated an interactive mobile application to explore how zoo visitors perceive LLM-powered infotainment and how it supports engagement. We conducted an initial pilot study to assess staff and visitor perceptions of infotainment at our local zoo, revealing a need for more accessible and engaging information. Moreover, we conducted a second pilot study to explore people's sentiments towards chatting with animal avatars. Based on these pilot studies, we derived insights informing the design and development of *Zoodex*, a text-based system for engaging with digital representations of zoo animals. *Zoodex* is an LLM-powered mobile application with image classification functionality, designed to encourage visitors to explore, identify, and learn about animals throughout the zoo. We evaluated our application at the zoo through observations and group interviews with teenagers ($N = 20$), a demographic that often loses interest in zoo visits as they grow older.

Our findings suggest that chatting with animal avatars has a positive impact on visitor engagement for our target audience. We found that encouraging visitors to adopt an active exploration role in the zoo increased their interest in discovery and fostered spontaneous social interactions within groups. Additionally, we found that the exploration and identification of animals encouraged visitors to visit areas of the zoo they might not otherwise have visited. We discuss our initial exploration of how non-human entities, such as animals, can be represented in conversational AI and reflect on the design considerations and ethical implications of such emulated interactions.

2 Related Work

Grajal et al. [18] argue that people's sense of connection to animals is strongly related to self-reported pro-environmental behaviours. Building on this insight, they conclude that improving people's connection to animals can increase their involvement in environmental causes. Building on this, Amiot et al. [2] describe identification with animals as a multidimensional construct. One of these dimensions is human-animal similarity, defined as the perception that animals share similarities with humans. This dimension is associated with increased moral concern for their welfare and a greater attribution of human traits to other animals. It has been suggested that technology can help uncover emotional connections by prompting visitors to reflect on their emotional responses, thereby encouraging them to consider their emotions and personal experiences [1]. Similarly, Ciolfi and McLoughlin [10] suggest that connections to an exhibit are formed when interactive elements are personally relatable. While research shows that a personal connection to animals can be an essential factor in shaping pro-environmental behaviour [18, 43], it is unclear how interactive technologies can support and strengthen this connection.

Next, we report on prior work in interactive technologies implemented or explored in public spaces, as well as research on anthropomorphism and animals, and approaches to utilising conversational agents in various contexts.

2.1 Interactive Technologies in Public Spaces

Museums, zoos, and science centres may experiment with emerging technologies to augment and enrich visitors' experiences [20, 39, 44]. These informal settings, often referred to as 'free-choice'

learning, allow play and entertainment to be interwoven with education [43]. Free-choice learning is a type of learning that is self-directed, voluntary, and guided by the learner's needs and interests. Zoos often see themselves as an essential source of this type of learning [43]. Interactive systems have been found to offer opportunities to enhance visitors' experience of animal encounters [55], for example by encouraging visitors to engage in significantly more active sociocultural behaviours (e.g., sensemaking, discussion) [6] and verbal interaction [10], and enhance learning [26, 31, 38, 49]. Additionally, visitors spend significantly more time at zoo exhibits during live presentations or in the presence of educational videos [38]. However, the appearance and use of technology may run counter to expectations of naturalistic zoo landscapes and risk distracting from visitors' encounters with animals [55]. Concerns have also been raised about how to reduce the time visitors spend looking at their phones [6]. Consequently, a central challenge is designing and implementing systems that strengthen, rather than detract from, visitors' visual connection with the animals, as face-to-face interaction is the primary attraction for zoos [26].

We organise prior work on interactive technologies in public spaces into three broad categories: interactive installations and exhibit technologies, mobile and playful systems, and immersive and emerging technologies.

Interactive installations and exhibit technologies. Prior work has explored how technology can assist zoo staff in explaining and interpreting the exhibits to the visitors. For example, a tablet mirrored on a larger screen to display information to a wider audience could help staff remember information and enable addressing a broader audience without hindering mobility, while also retaining face-to-face connections with visitors [24]. As an alternative use of technology in the zoo, researchers placed a robot in a zoo exhibit in place of an animal and examined visitors' initial reactions. While responses were generally positive, more than 60% did not perceive it as a real animal. Despite this, the robot was considered a successful attraction, suggesting that a zoo exhibit need not feature live animals to engage and entertain visitors [13]. Furthermore, Webber et al. [55] studied the Zoopermarket, an interactive, supermarket-themed installation at Melbourne Zoo designed to engage visitors with conservation issues. The pre-existing system allowed visitors to scan everyday products using barcode scanners to learn about the impact of palm oil production on orangutan habitats. The system provided real-time feedback using a simple traffic-light rating, with green indicating high sustainability and red indicating poor practices by palm oil production companies. Visitors were also offered an easy way to email companies directly to advocate for more sustainable practices. This interactive experience encouraged deeper engagement with the conservation message at the orangutan exhibit, supporting the zoo's mission to combine recreation with education and raise conservation awareness.

Mobile and playful systems. Prior work has explored how mobile technologies and playful interaction designs can support visitor engagement in situ. Syiem et al. [50] developed an augmented reality system at a zoo that allowed visitors to scan signage and display 3D animal models on their mobile devices, providing educational content through audio, text, and visuals. This system enhanced engagement by enabling visitors to interact dynamically with animals and by supporting the zoo's educational mission through interactive conservation information. They conclude that their framework addresses challenges such as presenting conservation efforts, improving accessibility and enhancing visitor experiences without detracting from the physical interactions. Wein [58] studied the use of smartphones to obtain information on artwork in museums and found that visual identification was preferred over a keypad or QR codes. Their research provided strong evidence that visitors prefer this technology because they perceive it as a more natural and unobtrusive way to interact with the artwork. Cesário et al. [9] further show how mobile museum experiences for teenagers can be shaped through game-based and story-based tours, highlighting how such approaches can support enjoyment and engagement during visits. Similarly, Ryding [42] describes

a mobile system designed for social play in art museums, showing how playful interaction can foster personal, in-situ, and shared experiences. Together, these works help contextualise *Zoodex*'s playful design, particularly its emphasis on discovery, collection, and social interaction.

Immersive and emerging technologies. Prior work has also explored how immersive technologies can enhance visitor experiences. Webber et al. [56] explored the use of virtual reality (VR) in engaging zoo visitors with penguins, highlighting how immersive technologies can bridge physical and digital experiences to foster conservation awareness. Additionally, Yamazaki et al. [60] experimented with a museum guide robot at the Ohara Museum of Art. The robot used timed head movements, gestures, and questions to engage visitors. By asking questions about the exhibit, the robot encouraged visitors to participate actively rather than passively listen. This interactive approach increased visitors' engagement and enhanced their overall experience.

Beyond these technology categories, Dalsgaard et al. [11] highlight several key design considerations for encouraging visitor participation in public knowledge institutions. These include establishing common ground to foster shared interaction; promoting engagement through inquiry and exploration; and encouraging participation through construction and contribution.

In summary, while technologies offer significant opportunities to enhance visitor experiences in zoos and museums, a central challenge lies in designing systems that both engage and educate without detracting from the naturalistic settings these institutions provide. However, measuring educational effectiveness in such informal learning contexts remains methodologically challenging, as learning outcomes are difficult to assess beyond self-reported enjoyment or engagement [14].

2.2 Anthropomorphism and Animals

The use of LLMs to represent animals as actors with human traits, capable of understanding human language, is a clear case of anthropomorphism; the attribution of human characteristics to non-human entities. Anthropomorphism has long been employed as an educational tool in wildlife contexts. It has been shown to enhance people's sense of connectedness to animals, motivating efforts to protect habitats and prevent extinction [25]. The approach is often justified by moral inclusion, as Tam et al. describe it: "when an entity is anthropomorphised, it becomes deserving of moral consideration" [51, p. 6]. However, anthropomorphisation presents both benefits and risks, as anthropomorphic representations might impact people's perception of and behaviour towards animals, as well as their willingness to support the conservation of specific species [34].

Research by Manfredo et al. [34] suggests that anthropomorphism supports a value shift in wildlife orientations from one of domination to one of mutualism. This shift supports the emergence of 'compassionate conservation', emphasising coexistence and empathy toward animals. The authors found that anthropomorphism affects both value formation and attitudinal positions on wildlife, and call for studies that research the use of anthropomorphism as a tool for conservation. Such a study was conducted by Root-Bernstein et al. [41], who describe anthropomorphism as a powerful but double-edged sword. While anthropomorphism can increase empathy and motivate support for conservation efforts by highlighting commonalities between humans and animals, it may negatively impact these efforts by drawing people's attention to individuals or specific species, setting up expectations of human-like social behaviour that animals cannot satisfy, or attributing certain animals to negative social stereotypes. To avoid these adverse effects, the authors suggest that 'appropriate' anthropomorphism may be achieved by emphasising characteristics that species already possess and that can be experienced first-hand through personal interactions with the animals themselves.

Similarly, Grasso et al. [19] highlight how anthropomorphic representations of animals might contribute to a distorted understanding of the natural world, including animals' conservation status, natural behaviour, ecological importance, and suitability as pets. To avoid the lionisation

or demonisation of specific species, the authors recommend avoiding the portrayal of certain animals as ‘heroes’ and others as ‘antagonists’. They underscore the importance of this approach, particularly in children’s consumption of animal-themed media, as this generation will play a crucial role in addressing the impacts of global climate change in the future. Kamil et al. [25] demonstrated the effectiveness of combining anthropomorphism with factual information to educate children about Komodo dragon conservation. Their approach avoided excessive anthropomorphism—such as depicting animals standing on two legs or wearing clothing—but instead portrayed Komodo dragons as named characters that could speak, think, and have aspirations. The authors suggest this mix of anthropomorphism and factual information as a promising strategy for future conservation awareness programs.

2.3 Designing LLM-powered Conversational Agents

Utilising platforms such as *OpenAI*, conversational agents (CAs) can seamlessly assume different roles or characters to accommodate specific user requirements. By engineering precise prompts, historical, modern-day, or fictional figures can be brought to life to teach learners through ‘lived’ experiences [37] or enable visitors to engage in AI-powered, two-way conversations with animals, offering engaging educational experiences and fostering deeper connections with the natural world [39]. Using LLM-powered CAs presents several challenges, such as handling playful utterances. Addressing these problems could improve CAs’ ability to foster emotional relationships and increase user satisfaction, engagement, and loyalty [45]. This aligns with findings by García et al. [17] who demonstrated how conversational agents’ embodiment in virtual museum settings can significantly enhance engagement by creating relatable and interactive narratives. Adequately responding to playful interactions can strengthen the personality of CAs through a simulated sense of humour, although humour detection is inherently difficult due to its subjective nature [45, 61]. Sun et al. [47] also acknowledge that individual perceptions of CAs’ personae can vary, meaning that one personality is unlikely to accommodate all users. Personality congruence between users and CAs impacts engagement [46], usability, appropriateness [16], and perceived trustworthiness [30]. Studies show that consumer engagement improves when CAs’ personalities match user personalities, which can be achieved through the manipulation of response language during interactions [46]. Humour, particularly affiliative humour, enhances user engagement and adherence to health behaviour interventions using CAs [48].

Effective CA design requires striking a balance between human-like traits and responsiveness. Self-editing and optimal response times help increase the perceived authenticity. Optimal response times involve a delay that mimics human thought processes, as overly fast replies can seem artificial, while hesitations and self-edits can create a more thoughtful and engaging interaction [62]. CAs might be equipped not only with fundamental character traits such as demographics, age, and gender, but also with corresponding professional knowledge that aligns with their identities [47]. Furthermore, being able to express sympathy and empathy is also perceived positively, especially for users initially sceptical about machines’ social cognitive capabilities [32]. Additionally, CAs should be consistent and maintain ethical considerations [47]. Thus, CAs that effectively integrate humour, match user personalities, and exhibit human-like behaviours are more likely to result in positive user experiences.

However, we know little about people’s perceptions of digital animal representations that resonate with zoo visitors. Therefore, we set out to explore how LLM-powered CAs can be explicitly designed for zoo environments.

3 Formative Studies

Considering our goal of introducing and evaluating an LLM-powered interactive prototype in a real-world context, we acknowledge the importance of initial exploration of our problem domain. We therefore planned and executed two pilot studies. This section describes these, focusing on zoo visitors, employees, and design conceptualisations. In Pilot Study 1, we conducted in situ interviews to explore visitors' and employees' sentiments towards the use of interactive technologies at *Aalborg Zoo*. In Pilot Study 2, we interviewed participants to evaluate the concept of chatting with animals. From both pilot studies, we derived insights to inform our prototype system, as presented in Section 4.

3.1 Pilot Study 1: Zoo Visitors and Zoo Employees

We conducted seven interviews with 13 participants: eight zoo visitors and five zoo employees. The zoo visitors willing to participate in our pilot were a mother with two teenage children (a boy and a girl), a mother with two young adult sons in their early twenties, and a man and a woman in their late twenties. The five employees were all adult women working in mediation roles at the zoo. Participants were recruited opportunistically on-site during a typical day at the zoo, so that responses reflected real-world visitor and staff experiences rather than controlled or pre-selected samples. We asked participants whether they would participate in an interview and whether they were willing to consent to being recorded. The interviews lasted up to 10 minutes, and participants were informed that their responses would remain anonymous. As this was a formative study, our recruitment strategy was broad, targeting all visitors to the zoo during the study period. This allowed us to gain early insights across age groups and motivations for visits. The employee interviews were designed to capture a broad range of perspectives on visitor behaviour across different demographics, complementing the insights gathered from the visitor interviews. Interview guide questions centred on the type of information participants prefer, their views on the park signage, and the use of technology in the zoo. Example questions include: *'What kind of information are people interested in?'* and *'Do you think any information is missing from the signs?'*

3.1.1 Results. To analyse the interview data, we transcribed all interviews and conducted an inductive qualitative analysis inspired by thematic analysis [5]. As this was a formative study aimed at generating early-stage design insights rather than an exhaustive interpretive account, we adopted a pragmatic and lightweight approach rather than strictly following all phases typically associated with a full thematic analysis. We colour-coded and clustered quotations by topic to identify recurring patterns in participants' responses. These clusters were reviewed collaboratively and iteratively refined into codes and broader themes, which informed the following design insights:

Visitors highlighted the value of having access to both fundamental and entertaining animal facts to enrich their zoo experience, suggesting the importance of **providing basic and fun animal facts through enjoyable interactions**. Both visitors and staff emphasised the effectiveness and appeal of interactive learning experiences. Visitors particularly noted the benefits for children, with one participant explaining: *"In this way, you learn about the animals by making it interactive. That is a great way of learning as a child"* (A11).

Participants also expressed enjoyment in documenting their zoo visits, for example through photographs or checklists, highlighting the value of **facilitating documentation of visited animals**. One group described how they had been marking which animals they had seen on the zoo map, but found it inconvenient when the map was folded: *"We have been marking which animals we saw [on the zoo map] [...] But then when the map is [folded] you cannot interact with it"* (A1). Another participant highlighted the appeal of documenting animals digitally: *"It is actually the mission of the day to take pictures of all the animals we see"* (A3).

Finally, participants expressed differing attitudes toward using mobile phones during zoo visits, suggesting the need to **balance digital and analogue experiences in zoo visits**. Some preferred a more analogue experience, noting: “*I like it that I do not have to use my phone for the information*” (A2), and “*I prefer things to be as analogue as possible*” (A8). At the same time, others recognised the potential of mobile technology to enhance the visit. One participant noted, “*It would be more of an enhancement of the experience*” (A3), while another found the idea of discovering animals through a phone appealing: “*That sounds brilliant, it sounds quite cool*” (A9).

3.2 Pilot Study 2: Animal Avatar Design Conceptualisations

Sense of connection to animals and pro-environmental behaviours correlate [18]. We aimed to leverage this insight by exploring a design concept that connects users to zoo animals. Identification with animals can be enhanced if the animals share similarities with humans [2], suggesting that ‘humanising’ animals could strengthen this connection. By designing digital representations of animals which communicate in human language, we sought to explore how information about zoo animals can be effectively communicated through these digital representations. We conducted a second pilot study to assess people’s perceptions of interacting with animal avatars.

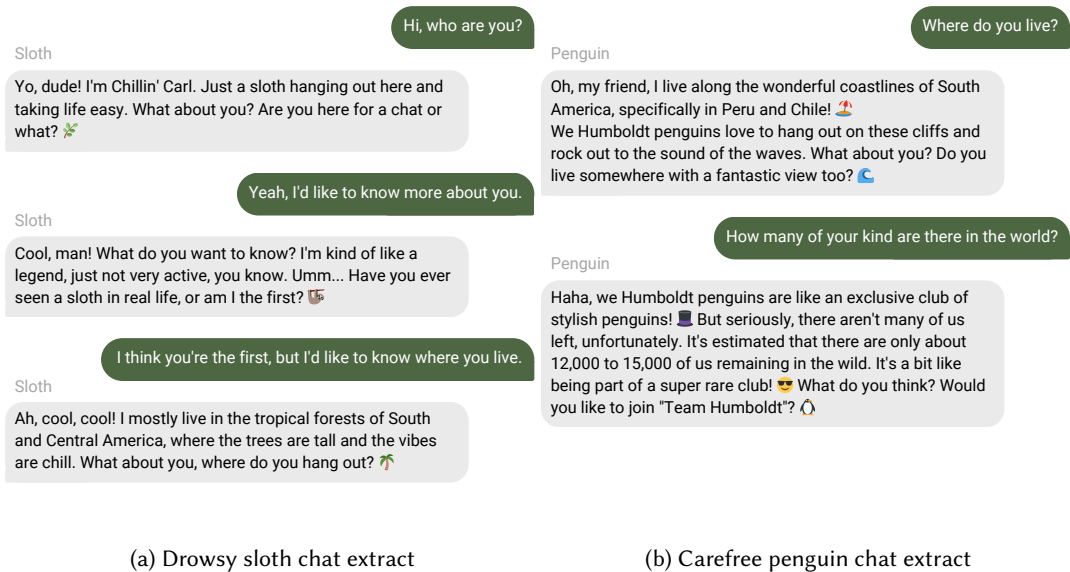


Fig. 2. Extracts of participants’ chats with two of the four animal avatars from Pilot Study 2, illustrating their distinct personalities.

3.2.1 Design Conceptualisation. Over several iterations, we developed four prompts to serve as LLM-powered representations of animals commonly found in zoos. We selected four animals to provide contrasting personalities and conservation statuses, exploring how these factors might influence participants’ responses to and engagement with the animal avatars. The *gloomy elephant* and the *carefree penguin* were chosen to represent endangered species with contrasting emotional responses: the elephant being sad and angry about its endangered status, and the penguin remaining happy and joking despite it. In contrast, the *audacious snake* and the *drowsy sloth* were selected as non-endangered animals with stoic personalities: the snake was portrayed as bold and sassy,

while its laziness and relaxed attitude characterised the sloth. We acknowledge that linking animal personalities to conservation status risks oversimplifying complex conservation issues; we return to this limitation in the Discussion. We aimed to include a diverse set of personalities to make each animal-avatar interaction unique. These personalities were designed to make the avatars noticeable and distinctive, allowing participants to form clear opinions about them. ChatGPT-3.5 was utilised for the evaluation, with prompts provided via ChatGPT's custom response instructions [36], ensuring that the animal's digital representation would behave in accordance with the provided descriptions. For example, the prompt for the sloth was as follows:

Answer me like you are a lazy, chill, funny, sleepy, hippie, and real two-toed sloth. Act like Chicken Joe from Surf's Up. Give yourself a relevant name. You are not endangered, so you are chilling. Make answers 2–4 sentences long. It is a dialogue, so you should ask me questions sometimes. Use emojis. Keep things factual. Write "Umm..." and "..." in your text.

These prompts generated interactions similar to the two excerpts from participant conversations shown in Figure 2.

3.2.2 Participants. We evaluated these four different animal avatars with a total of ten participants, all of whom were university students with a background in digital design and development, as recruited through convenience sampling. We consider this sample particularly meaningful, as the participants' expertise in interaction design and experience building AI prototypes made them well-suited to identify design and interaction issues at this early stage. While our final evaluation targeted teenagers, we used university students with relevant educational backgrounds in this pilot study to rapidly iterate on the avatar designs and identify fundamental issues in the conversational interactions before deploying with younger participants in a more resource-intensive field study.

3.2.3 Procedure. We defined two roles for our participants to assume when interacting with the animal avatars: the 'researcher' and the 'explorer'. This approach was designed to compare how users would engage when tasked with specific objectives versus when not. As *researchers*, participants were tasked with using a predefined set of factual questions to elicit information about the animal avatar, such as its weight, habitat, and diet. As *explorers*, participants were given no specific task but were instructed to chat freely with the animal avatar.

Participants completed these tasks in groups of two or three, each seated around a table with a laptop running a conversational interface for each of the four animals. All participants tried both roles and conversed with two of the four animal avatars, switching roles and animals after approximately three minutes. This duration was chosen because we deemed it sufficient for participants to familiarise themselves with the animal avatars and their personalities, but brief enough to prevent interactions from feeling repetitive. Subsequently, we conducted group interviews to elicit participants' experiences. Interview questions focused on participants' experiences chatting with the animal avatars, the avatars' personalities, the acquisition and relevance of information, and the extent to which participants felt that chatting created or deepened a connection between themselves and the animals. These sessions took approximately 15 minutes altogether.

3.2.4 Results. We transcribed the post-chat interviews and identified themes based on recurring codes. We then translated this knowledge into several design insights for the proposed 'chatting with animals' feature. These insights are outlined in the following sections.

Participants generally expressed positive sentiments towards receiving information through chatting with representations of zoo animals, favouring this approach over interactions with more generic chatbots. Some participants, however, noted that the brief introduction was insufficient to establish an emotional connection. Many reported learning new information and finding most, if not all, desired facts in the researcher role. Participants generally enjoyed the explorer role

more, but found the researcher role easier because of the predefined questions. Participants further indicated that initiating conversations unprompted was challenging, suggesting a need to **facilitate engagement and conversation starters**. This was reflected in comments such as “[*The explorer role*] was more fun, but then, what the heck am I supposed to ask it about?” (B4) and “*It was a bit tricky, you know, unprompted...how you were supposed to just start a conversation*” (B8). Providing initial prompts or having the animal avatars initiate conversations could help address this challenge.

Participants also highlighted the importance of **balancing personality and factual accuracy**. The animal avatars occasionally provided incorrect answers regarding their subspecies when asked. For instance, the Humboldt penguin mistakenly described itself as living in Antarctica, whereas these penguins actually inhabit the Pacific coast of Peru and Chile. The avatars must provide accurate information to maintain credibility and educational value. At the same time, their strong personalities could lead to vague or inaccurate responses, which some participants found frustrating when seeking factual information. For example, when asked “*How much do you weigh?*” (B5), the audacious snake responded with “*I am light as a feather and agile as a dancer*”, evading the question. While some participants appreciated the personality alignment, others felt it hindered engagement. Participants also highlighted the value of the animal avatars sharing unsolicited facts about their species to foster engagement.

Finally, participants emphasised the importance of **maintaining novelty and enhancing conversation dynamics**. Several found the animal avatars monotonous when they repeatedly focused on the same concerns or traits. Comments such as “*It kept talking about the same thing all the time...It drove me a bit mad in the end*” (B2) suggest that varying the content and structure of responses could create more dynamic and engaging conversations. Participants also expressed a desire to switch animals periodically, as the novelty of each avatar’s personality was a key motivator for engagement: “*I would want to change animals regularly [...] I mean, I thought they were fun to write with, but at some point you realise that the sloth is just really chill*” (B7). While most participants appreciated the animals’ strong and distinct personalities, they consistently noted that the elephant was overly negative: “*The elephant, I might say, could also be toned down a bit. It seemed intent on making me feel bad about myself.*” (B7). However, this same personality led participants to inquire more about how they could help the endangered animal: “*Does it help the elephant that I pay for my ticket to the zoo?*” (B1). This suggests that strong narratives may increase interest in conservation efforts, even if they occasionally result in a more negative experience.

4 LLM-powered Infotainment and Zoodex

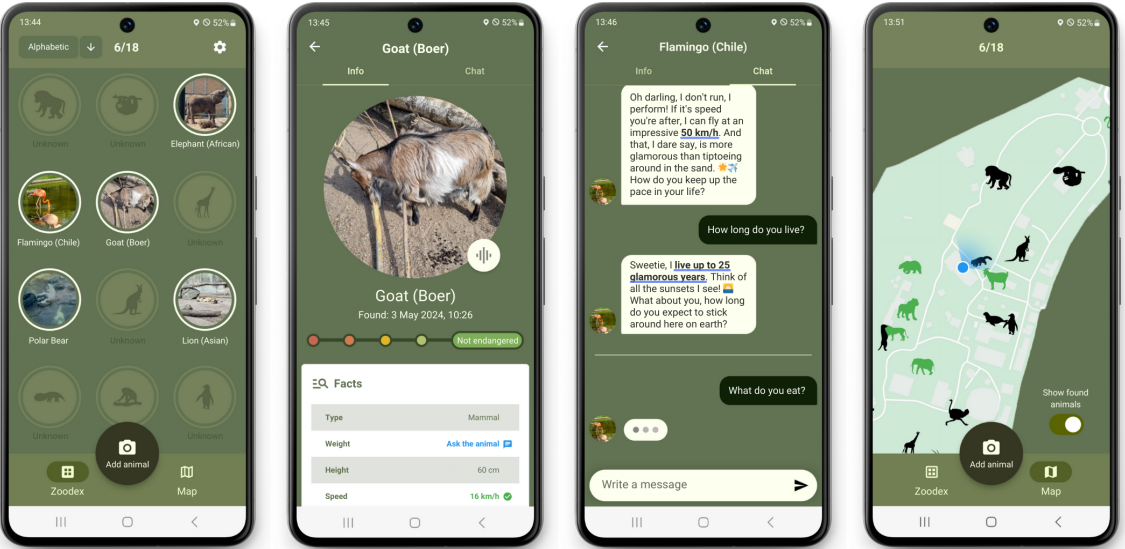
We next describe *Zoodex*, a mobile application that enables zoo visitors to engage in conversations with digital representations of animals encountered during a zoo visit. In contrast to traditional educational methods that rely on passive information delivery, *Zoodex* promotes active engagement by encouraging users to explore and document animals, learning about their species in a way that blends physical and digital experiences. This approach aims to maintain the zoo’s atmosphere while supporting visitor engagement [57].

4.1 Zoodex

The development of *Zoodex* is informed by previous research on engaging with nature through technology [57] and our aforementioned pilot studies (see Table 1 for an overview). From the first pilot study, we recognised that visitors were interested in basic facts about animals and learning through interaction (Insight 1), as well as in documenting their visits (Insight 2). In the second pilot study, we observed that interacting with animal avatars may be a promising approach to supporting aspects of free-choice learning. To foster engagement, we thus sought to develop an interactive method for zoo visitors to document the animals they encounter.

Table 1. Overview of insights from the formative studies and how they informed the design of *Zoodex*.

Study	Insight	How it informed design	What we implemented
Pilot 1	(1) Animal facts	Combine educational and entertaining content to sustain engagement and support interactive learning	Animal avatars provide essential facts through playful, conversational interactions
Pilot 1	(2) Animal documentation	Support collection and tracking of animals seen during the visit	Animal scanning, fact collection, and a visual collection of discovered animals
Pilot 1	(3) Digital vs. analogue	Keep interactions lightweight, optional, and integrated into the physical zoo experience	Quick scan-based interactions and optional chat-based exploration
Pilot 2	(4) Conversation starters	Provide prompts or guidance when initiating conversations with animal avatars	Suggested prompts, predefined questions, and animal-initiated conversation openers
Pilot 2	(5) Personality and factuality	Maintain engaging personalities while ensuring educational credibility and clear factual responses	Hard-coded facts in prompts and designed distinct but moderated avatar personalities
Pilot 2	(6) Dynamic Engagement	Vary interactions and leverage strong narratives to sustain engagement and encourage reflection	Distinct personalities, unsolicited facts, and multiple animal avatars to interact with



(a) Discovery page

(b) Fact page

(c) Chat page

(d) Map page

Fig. 3. Screenshots of various pages of the *Zoodex* application.

Zoodex tasks visitors to ‘discovering’ species by photographing animals around the zoo. The app name references the well-known *Pokédex* from the Pokémon franchise to evoke a familiar sense of discovery and collection, while drawing gameplay inspiration from *Pokémon Go*. In *Pokémon Go*, players must physically move through outdoor environments to locate and capture virtual creatures. This mechanic has been shown to increase physical activity and encourage exploration of real-world spaces [23]. Following Insight 3, this approach balances the digital and analogue experience by inviting users to explore the zoo’s physical space. Initially, all animals are marked as undiscovered and only silhouettes are visible. As users add animals to their discoveries, these silhouettes are filled out, as seen in Figure 3a. Once discovered, users gain access to basic information about the animals (see Figure 3b) and can chat with the animals’ respective digital representations (see Figure 3c). To obtain an overview of the animals’ locations, the app features a zoo map with all animal locations, where colour indicates whether each animal has been found, as shown in Figure 3d.

When accessing the information page of each animal, three facts are initially hidden. The user must interact with the animal to obtain the missing information. Each of these facts can be tapped to automatically initiate a conversation about that fact. As per Insight 4, this provides users with a conversation starter and a reason to engage. When an animal provides an answer to a missing fact, the information is underlined, and users can tap to save it. The corresponding fact is consequently revealed on the information page and accompanied by a green tick.

According to our pilot studies and prior research, zoo visitors seek interactive experiences, which have been found to foster engagement, immersion [35], and learning [38]. Drawing inspiration from wildlife researchers who explore and document new species, we aimed to integrate this metaphor into the application. By engaging users in the role of animal researchers, we seek to transform the process of discovering animals and collecting knowledge into active exploration. The application aims to foster engagement at the zoo by providing interactive content about animals and their conservation status. The animal’s conservation status is prominently displayed at the top of each animal’s information page and influences its personality during chat interactions. For example, if an animal is extinct in the wild, its mood may be portrayed as sad or frustrated, which can guide the conversation towards conservation issues. On the other hand, an animal that is not endangered might display a relaxed, easy-going, and playful personality.

We draw inspiration from the concept of playful personas, as seen in animated films, and from research on young people’s desire to identify with television characters [22]. The animal avatars have strong, prominent personalities, which can make them more memorable and entertaining. Johnston & Thomas, two key animators at Disney, described how the more caricatured an animal is portrayed, the more it captures the essence of that animal. On the other hand, if the animal is perceived as too realistic, there is little potential for acting and personality [52].

4.2 Implementation

We initially prototyped *Zoodex* in *Figma*, undergoing several design iterations. The final application was developed using the cross-platform *Flutter* framework, leveraging packages such as *TensorFlow* for image classification and the *Dart* package to enable a chat implementation using OpenAI’s GPT-4. Because GPT-4’s output is nondeterministic, it can be challenging to determine whether an animal has provided a collectable fact. To mitigate this, we hard-coded desired responses to user questions into the system prompt, as can be seen in the prompt we applied for a flamingo:

Respond as if you are a sarcastic, diva Chilean flamingo. Say this if asked about weight ‘I weigh 2.1–4.1 kg’, food ‘I eat everything’, chicks ‘I have one chick at a time’, lifespan ‘I live 25 years’, speed ‘I can fly at 50 km/h’, and add a bit more info when you respond. Give yourself a relevant name. You are a real animal. Your species is not endangered. You can

use a maximum of 50 words. It is a dialogue, so you can also ask me questions occasionally, but not in every message. You must use emojis. Make sure to respond factually.

The last sentence was included in line with Insight 5, prompting the animal avatars to prioritise factual accuracy over adherence to their assigned personalities, although this could not be reliably enforced. The instruction to avoid asking questions in every message originated from Insight 6.

Toups Dugas et al. investigated players' collecting behaviours in digital games to determine what digital game objects players enjoyed collecting and why they valued these objects [53]. Their results suggest that digital game objects that influence game mechanics or elicit social interest are the most commonly collected. In *Zoodex*, this social interest may derive from competing to 'discover' the most animals, learn the most facts, or capture the best pictures. To support the discovery of digital animals, we employed image classification to verify that the animal was indeed observed. In contrast to other methods such as QR codes, this approach also allows visitors to maintain important visual contact with the animals on exhibit [26, 58]. We implemented a fallback option that allowed users to manually select the correct animal if image recognition failed.

5 Evaluation

We conducted an in situ evaluation session at Aalborg Zoo to evaluate *Zoodex*. Our evaluation consisted of observations and interviews, resulting in a dataset of notes describing participant behaviour, including how they interacted with the app, their environment, and each other, as well as interview transcriptions detailing participants' perspectives on the application's concept.



(a) Participant using Zoodex at the elephant enclosure.



(b) Participants observing a lorikeet, illustrating attention towards the animals during the experience.

Fig. 4. Evaluation of the Zoodex application at Aalborg Zoo.

5.1 Participants

In collaboration with Aalborg Zoo, we arranged a two-hour class visit from a local seventh-grade school class. The class consisted of 20 teenagers, aged 12 to 14, with ten boys and ten girls. The school visits the zoo once or twice a year, and consequently, most participants were familiar with the animals, exhibits, and layout of the zoo. This age group was selected in collaboration with zoo staff, who noted that teenagers represent a critical demographic. The staff described how younger audiences typically show high interest in animals and zoo experiences, but that this enthusiasm tends to decline during the early teenage years. Thus, the zoo is particularly interested in finding

ways to sustain engagement among teenagers before their interest fades. Before the evaluation, consent was obtained through the school, with the teacher responsible for ensuring that necessary parental or guardian permissions were in place.

5.2 Procedure

The teenagers organised themselves into six groups of 3–4 people. Each group was assigned a researcher who would observe them during the evaluation. Each group also received a smartphone on which we had installed the *Zoodex* application. After a brief verbal introduction to the application, the groups were asked to begin their visit to the zoo. All group members were given three tasks: (1) find an animal and scan it, (2) find the three missing animal facts using the chat, and (3) ask the animal questions of their choice.

Groups had 40 minutes to complete these tasks. If they completed the tasks before the allotted time expired, we encouraged them to continue using the app for the remainder of the allotted time. Participants had the freedom to decide where to go and which animals to find (see Figure 4). During the evaluation, researchers recorded noteworthy observations, such as how the application's use affected participants' awareness of their surroundings or their group's interaction.

Following these 40 minutes, each group participated in a semi-structured interview lasting up to ten minutes. The interviews focused on participants' experiences with the application, its impact on the zoo experience, the use of image classification, engagement through exploration and interaction with animals, and its effect on participants' engagement at the zoo. Example questions included: "How was it to walk around the zoo using the app?", "Did the app make you more aware of which animals you were looking at?", "Did you learn anything by using the app? What?", and "Was there anything you found hard to understand or misunderstood?"

5.3 Analysis and Results

We transcribed each interview and collectively went through the steps of thematic analysis [5]. A majority of the authors familiarised themselves with the data by reading through each transcript twice. We then collectively reviewed the transcripts and highlighted quotes that we deemed valuable or surprising. Initially, we highlighted 251 quotes across the six interview transcriptions, which we later refined to 174. All quotes were added to a shared collaborative whiteboard, where we collectively identified quotes with the same codes to cluster them into categories. The resulting categories underwent three iterations, being dissolved and reworked, merged, or divided, until we were left with four categories. The codes of each category were then reviewed and discussed to establish preliminary themes. After multiple iterations, we report results on four themes: Discovering Species; Chatting with Animals; Social vs. Individual Use; and Engagement with Animals. We selected quotes presented below to illustrate each theme; both positive and critical perspectives emerged in our data, and we include examples of each where relevant.

5.3.1 Discovering Species. The first theme concerns participants' experiences of assuming the role of researchers studying animals, and of discovering species by photographing them. Participants appreciated the process of having to find species in the app by locating them in the park: "Fun. Really, really fun. It is more enjoyable than the usual experience [...] Maybe 50% better actually" (P12). Another participant noted that it was "good because then you also get some exercise" (P16). When asked about the intrusiveness of the application to the zoo experience, one participant responded "I love walking around with my phone, I think it is nice" (P12). In a few instances, we observed participants who were so occupied with using the app that they almost walked into obstacles, a point also noted by one participant: "It was quite nice, but you have to remember to look up once in a while" (P2).

Occasions of failed image classification did not appear to frustrate participants. One participant said *"I found it quite amusing when it went completely wrong"* (P19), while others seemed to like the challenge of having to get good pictures of the animals: *"It was because they were hiding a bit. It was quite amusing to see, so I did not mind when it did not work."* (P5). As participants could correct the detected animal, they never had to spend long to resolve the incorrect classification: *"It is good that you can select it so you do not have to keep taking pictures"* (P12). Our observations also revealed that some participants used the map page to locate animals they had not yet added to their discoveries. This appeared to encourage our participants to visit animals they might not otherwise have been particularly interested in. Although groups were asked to identify one animal per group member, all groups identified more than that, with one group adding 13 species to their list. One participant also stressed the importance of being physically near the animals, expressing that this is an important part of the experience: *"If you are not near the animal, it is not really finding the animals"* (P12).

A majority of participants expressed that the app was a good alternative to reading the zoo's signs, as it provides a more interactive experience. One participant commented that *"it is really good to have, such a nice alternative to those, umm...[signs]...that just have a lot of facts on them [...] It gets straight to the point instead of you having to read all sorts of other things"* (P2). Another participant added: *"It is good that you have to do something to find out, rather than just sitting and staring at a sign."* (P16). Furthermore, a majority of participants indicated that they learned something: *"Yeah, something about weight, something about speed...a little bit of everything"* (P12). Some participants demonstrated this by retaining the information during the interviews, whereas most of what they learned was directly related to the three facts they were asked to identify. For each animal, the three missing facts were randomly selected from the set of weight, speed, diet, number of offspring, and life expectancy, matching the facts that participants remembered. For example: *"I did not know that an elephant could live up to 70 years"* (P17) and: *"Now I can remember that the polar bear could run 16 kilometres per hour...no, 60 kilometres per hour"* (P19).

5.3.2 Chatting with Animals. The second theme concerns chatting with the animals and learning facts by asking them questions. The majority of participants found chatting with animal avatars both enjoyable and educational. One participant said, *"I thought it was great because you got a bit in touch with them"* (P21), to which another participant responded, *"Yeah, and you could just find out things if you wanted to"* (P19). Another participant compared it favourably to the signs one would usually find such information on: *"It was a bit more fun than just reading a sign and then trying to find what you want to find"* (P12). For the same participant, the chat also made the process of getting information feel more interactive: *"It was really cool [...] then you actually had to go in and chat with it before you got the information"* (P12).

One participant expressed that she liked how the animal avatars elaborated on their answers, as this made it feel more like a conversation: *"I felt like it answered a bit more than I asked. I thought that was cool, too. Because then you got more of a conversation."* (P21). Another participant stated: *"It was pretty funny that it could also answer the questions we asked it"* (P17). This was also reflected in how participants described the animal avatars as staying in their role, even when answering questions unrelated to animals: *"It still focuses on polar bears [...] So it is not the AI, it is still the polar bear you are talking to"* (P1). However, the chat was not always experienced primarily as a personality-driven interaction. Some participants were so focused on the facts that they barely noticed the personalities of the animals: *"I only noticed what was underlined"* (P17), one participant said. Another described how he did not look too closely at the text, as what he cared about was collecting the facts: *"It is not really something I read into much. It was more just the facts, but...it is funny how it says those things"* (P12).

5.3.3 Social vs. Individual Use. The third theme concerns the impact of the application on participants' social experiences and group dynamics. We observed that *Zoodex* facilitated social interactions between group members, even though the application did not include dedicated social features. Because each group shared one phone, participants typically took turns operating the application as they moved between animals. This was reflected in one group explaining that they each got to chat with one animal: *"We did not get to chat with that many. We got to chat with one each"* (P19). While one participant operated the phone at a time, the other participants contributed by locating animals, suggesting questions, or discussing the animal avatars' responses. This made the interaction a shared activity rather than an individual screen experience.

Multiple groups turned the process of discovering the missing facts for each animal into a shared activity, such as asking other members to guess the correct answer before asking the animal avatar and seeing who was closest. This made the fact-finding task a shared activity around animal knowledge, rather than simply a matter of reading the information from the screen. Many participants also found it fun to try the image classification on each other, seeing what animal the app would classify them as. In this way, the application supported shared attention and interaction within the groups.

Participants also imagined *Zoodex* as something they would use with others outside the evaluation setting. Several described using it with parents, friends, siblings, or younger children, suggesting that the application could fit into existing social forms of zoo visits. One participant explained, *"I also think that if you are out with your parents or friends or something like that, [using the app] is just nice"* (P6). Similarly, another participant said they could imagine using the application *"if we came to the zoo with the guys"* (P16). A third participant imagined using it when a parent asked about an animal: *"Maybe if I was with my family [...] [then] I could just whip it out when Mum asks 'how fast can that one run?'"* (P2). This suggests that participants saw the application not only as an individual learning tool, but also as something that could support shared attention and conversation during zoo visits.

5.3.4 Engagement with Animals. The fourth theme concerns how chatting with animal avatars influenced participants' sense of engagement with the animals at the zoo. Although it was not the actual animal they chatted with, several participants described feeling as if they were engaging with the animals directly: *"I felt like they were actually, like, speaking to me [...] I definitely felt like it was that polar bear I saw over there [that I was chatting with]"* (P21). This suggests a sense of connection between the digital avatar and the physical animal, further described by (P10): *"Even though it was not the animal speaking, it is what the animal would have said. If they could talk, that is how they would express themselves."*

Others expressed how chatting with the animal avatars did not just feel like chatting with a robot: *"You felt that it had a personality. I would also say that it was not just a robot"* (P20). While these participants felt that they were chatting with the specific animal at the zoo, others felt they were chatting with the species more generally, stating that they preferred it this way, because *"Then you can see how much it typically weighs on average and how old it can get"* (P7). In general, participants enjoyed the personalities of the animal avatars and how these were reflected in their responses. One participant noted how *"It replies in a funnier way, with a twist"* (P1) while others focused more on the names: *"I think it is cool how it introduces itself with a name and all that...that is really neat"* (P12). Talking about the 'audacious flamingo', one participant expressed how she felt its personality was quite accurate, saying she could imagine this as the personality of a flamingo: *"One could certainly imagine that if animals had personalities, they might have one like that."* (P11). Not all participants believed that chatting with animal avatars affected their engagement with the

animals at the zoo. As one participant stated “*Not by chatting with them because you do not really know, maybe if you add a voice to it, I think you get a little better understanding*” (P2).

6 Discussion

In this study, we explored how novel technologies, particularly LLMs, could support visitor engagement at the zoo and provide insights into the use of emulated interactions for infotainment purposes. The motivation for this builds on the established notion that increasing one’s awareness of animals can lead to both increased conservation awareness and pro-environmental behaviour [18]. Our pilot studies revealed a need to combine information intake with entertainment to maintain engagement and to balance digital and analogue experiences. These findings align with prior studies that highlight potential disruptions caused by phones in the zoo [55]. Our evaluation of an interactive mobile application revealed that participants found the app engaging and enjoyable, suggesting that mobile technology incorporating playful and conversational elements has the potential to support visitor experiences at zoos.

Importantly, the app’s gamification mechanisms likely affected participants’ behavioural engagement, such as actively moving around the zoo, scanning animals, collecting facts, and playing the guessing game, rather than just the inclusion of animal avatars. The conversational interactions may have contributed more specifically to entertainment and to fostering a perceived sense of connection with the digital animal representations, rather than directly influencing visitors’ physical behaviours. Relatedly, prior research has demonstrated people’s clear preferences for visual identification technology over keypads or QR codes in museums due to its intuitive and seamless nature [58]. Our findings similarly suggest that using visual recognition to identify zoo animals can support engagement by making interactions more immediate and playful, reinforcing the potential of visual recognition technology in educational contexts.

We note that our evaluation focused on visitor experiences and self-reported engagement; we did not measure learning outcomes, behavioural changes, or effects on the animals themselves. While participants reported finding the app entertaining and supportive in the learning of facts about animals, we cannot make claims about its educational effectiveness relative to traditional methods, nor about whether the experience influenced pro-environmental attitudes or behaviours. These remain important questions for future research.

6.1 Challenges around Anthropomorphising Animals

In *Zoodex*, we aimed to balance tensions around anthropomorphism by embedding factual accuracy into animal avatars while leveraging anthropomorphic traits to foster engagement. Yet, challenges remain. Overly humanised personalities risk overshadowing conservation messaging or creating unrealistic expectations of animal behaviour [19]. Maintaining factual consistency in dynamically generated conversations is also challenging, and digital avatars may distract visitors from observing real animal behaviours. In educational contexts such as zoos, this further raises concerns about LLM hallucinations and inaccurate information. Such risks could be mitigated by making greater use of zoo-authored responses for common or specific facts, rather than generating answers freely.

A specific concern in our design is the mapping of conservation status to avatar personality, for example by portraying endangered animals as sad or frustrated. This risks oversimplifying complex conservation issues and creating problematic associations (e.g., that endangerment is an emotional state rather than an ecological condition). This design choice also does not reflect how animals actually experience their circumstances. Future designs might therefore explore alternative approaches, such as decoupling personality from conservation status or presenting conservation information through narrative rather than emotional framing. Pataranutaporn et al. [37] demonstrated that AI-generated characters can enhance personalised learning experiences.

We similarly used AI-generated characters, although focused on giving animals a ‘voice’ through conversational avatars in a zoo setting. However, anthropomorphism carries both benefits and drawbacks. The use of LLMs to create animal avatars inherently relies on anthropomorphism, attributing human characteristics to non-human entities. This might foster empathy and affect emotional connections to animals [25], as well as encourage moral consideration, where animals are seen as more deserving of care and empathy [51, p. 6]. At the same time, anthropomorphism risks distorting perceptions of animals’ natural behaviour, conservation status, and ecological roles [34, 41]. These distortions may lead visitors to focus on anthropomorphic personalities rather than understanding the natural behaviours or conservation needs of animals.

Addressing these tensions requires ongoing reflection to ensure these interactions effectively balance personality, accuracy, and educational value. While the *Zoodex* application may foster engagement at the zoo through emulated interaction, the full potential of this approach and the broader design space require further investigation.

This resonates with Kneile et al.’s discussion of technologies that mediate human-nature relations, in which digital systems can both foster emotional connection and care and risk the simplification or instrumentalisation of non-human beings through anthropocentric framings [28]. In our case, portraying animals as playful conversational avatars may increase engagement while simultaneously shifting attention away from the animals themselves or oversimplifying their ecological realities. The implications of such outcomes were not systematically studied in this work. The design of our application emphasises user enjoyment over conservation information, which could downplay the seriousness of issues facing endangered species. Here, striking the right balance between education and entertainment is key. Overall, *Zoodex* shows potential as a technology-based tool for supporting zoo visitor experiences, although its impact on conservation awareness and broader appeal warrants further investigation.

6.2 Emulated Interactions in Engaging with Nature

Grounded in and motivated by humans’ disconnect with nature, Webber et al. [57] recently outlined how technological interactions can be categorised on their level of engagement ‘directness’ and ‘distance’ with nature. First, directness categorises interactions as direct or indirect (‘mediated’, ‘abstracted’, or ‘simulated’). Here, mediated interactions enable experiences of nature “not feasible in real-world interactions” (e.g., through photographs of nature). Abstracted interactions concern ways in which nature is represented through ‘forms’ different from what is represented (e.g., through field notes on nature). Lastly, simulated interactions regarding nature generated by technology to ‘recreate’ real-world experiences (e.g., nature in virtual reality).

Second, distance instead concerns the physical and perceptual proximity to nature, which is categorised as either ‘in situ’, ‘ex situ:nearby’ (i.e., engaging with nature close by), or ‘ex situ:distant’ (i.e., remote engagement). Combining these dimensions, for example, ‘in-situ simulated interactions’ capture computer-generated nature while in nature, while ‘ex-situ:distant mediated interactions’ capture “*mediated nature experienced at a remove from nature*” [57, p. 9].

Based on this typology, we classify the distance of the *Zoodex* prototype as in situ, with visitors engaging with the application at the zoo. However, the directness of our application cannot be readily captured by the existing typology. First, *Zoodex* enables users to interact with digital animal avatars by conversing with these in the presence of their real-world counterparts. This form of engagement differs from more ‘stilled’ interactions, such as taking pictures while in nature or otherwise unresponsive augmented nature environments. Second, these avatars are not static representations (i.e., unresponsive) but rather responsive digital representations of zoo animals, designed to engage visitors through their characteristics. Third, before conversing with the animal avatars, visitors must first locate their real-world counterparts. When visitors seek to engage with

another digital animal avatar, this process is repeated, resulting in visitors switching between modes of directness: direct engagement by identifying and locating the animals, followed by mediated engagement through conversation with the animal avatars (see Figure 1). Consequently, we extend the framework by Webber et al. [57] with a new type of directness: ‘emulated interaction’. We define emulated interaction as engagement with digital representations of real-world counterparts, where the digital representations can be extended to enable new forms of engagement. In our case, users can ‘talk’ with responsive LLM-powered avatars with distinct personalities that represent zoo animals. We use the term ‘emulated’ rather than ‘simulated’ to emphasise that these avatars do not attempt to faithfully replicate animal behaviour or cognition, but rather provide a human-interpretable interface to information about animals in their vicinity.

Furthermore, our evaluation indicates that participants found chatting with animal avatars entertaining and engaging. This aligns with findings by Amiot et al. [2] who noted that identification with animals through perceived similarities can increase moral concern for their welfare and lead to the attribution of human-like traits. We therefore suggest that assigning distinct personalities to animal avatars may make interactions more engaging and enjoyable. However, the downstream effects of such engagement on attitudes or behaviour remain to be studied. Distinct digital personalities can play an important role in digitally representing zoo animals across various contexts. However, designers must carefully consider the trade-offs between engagement and accurate representation discussed above.

Prior work outlines several design considerations relevant to technology mediating human experiences of animals. An important consideration is people’s varying knowledge of animals, as well as their divergent expectations and preferences, combined with animals’ unpredictable behaviours around or towards people [55]. When animals do not respond to human interactions as people expect, it can lead to feelings of disappointment. Conversely, while even one-sided interactions can lead to closer relationships between people and animals, a lack of respect or understanding of the animals may result in potentially harmful interactions [29]. Here, emulated interactions may complement visitors’ experiences by allowing them to learn about animals on their own terms. Such interactions could also potentially reduce pressure on animals to serve as readily available entertainment, though we did not study this directly. Prior speculative work has raised the question of what happens when animals are replaced by biohybrid robots [54]; emulated interactions represent an alternative approach that maintains the presence of real animals while augmenting the visitor experience digitally. More generally, emulated interactions can serve as a conceptual lens for describing interactive applications that bridge analogue and digital experiences.

6.3 Design Considerations around Emulated Interactions at Zoos

Based on our findings and the corresponding discussion (see Section 6.2), we propose three concrete design considerations for future conversational applications at zoos leveraging emulated interactions.

First, **use emulated interactions strategically to direct visitor attention**. Designers could, for example, deploy conversational avatars for less frequently visited or animals considered less charismatic to encourage exploration and redistribute engagement across exhibits. By selectively emulating specific animals, designers may actively influence visitors’ movement and attention throughout the zoo.

Second, **calibrate the intensity of anthropomorphic characteristics in emulated interactions**. Designers could tailor the strength and distinctiveness of each animal’s conversational profile to the exhibit’s goals. Stronger or more exaggerated personalities may help animals typically overlooked and capture attention, while more subtle portrayals may better suit already popular or iconic animals. This allows designers to balance engagement with accurate representation.

Third, **design emulated interactions to shape understanding beyond entertainment.** Rather than defaulting to consistently ‘happy’ or playful personalities, designers could craft personas that challenge misconceptions, provoke reflection, or communicate nuanced narratives. Such reflections would resonate with the concept of ‘Antagonistic AI’ recently outlined by HCI researchers as a response to sycophantic AI (e.g., LLMs’ tendencies to be overly agreeable) [7]. For example, animals associated with negative stereotypes or incorrect public perceptions could be designed to counter these assumptions through their conversational behaviour. Such personas may increase engagement while also shaping visitor attitudes and concern for animal welfare.

6.4 Limitations and Future Work

We recognise several limitations in our work.

Although our intention was to develop a research probe to explore the design space rather than a fully functional system, we acknowledge that our evaluation was limited to a single event and not conducted longitudinally. As with many research prototypes and probe-based systems in HCI, deploying Zoodex at the zoo would require longitudinal assessments to evaluate the application’s real-world applicability and potential.

Furthermore, participants conducted the evaluations in groups rather than individually, which likely influenced their interactions with the application. As a result, some of the observed interactions may have emerged from the group dynamics themselves rather than from the application’s design and functionality. However, this setup also reflects the social and often ‘messy’ nature of real-world zoo visits, where visitors likely navigate exhibits in groups rather than alone. While we observed shared engagement around a single device in our study, real-world usage may occur across multiple personal devices, potentially resulting in a more fragmented and less coordinated user experience.

Moreover, the physical presence of a researcher is likely to have influenced how participants engaged with both the application and one another, in line with the Hawthorne effect [33]. At the same time, researcher presence was necessary to guide participants through the study protocol and ensure consistent task completion. This reflects a common methodological tradeoff in HCI between minimising researcher influence and maintaining sufficient structure to capture meaningful interactions in in-the-wild evaluations.

The interaction with the animal avatars was limited to text-based conversations. To further improve the interaction between the user and the avatar, one participant suggested creating ‘verbal animals’ that could provide information and stories told from the animal’s perspective. AI voices have become nearly indistinguishable from human speech, and can thus provide a viable addition to the experience of interacting with animal avatars in future work. Prior work has shown that multimodal approaches can enhance educational content in zoo settings [50]. Future versions of *Zoodex* could also explore multimodal LLMs that interpret live visual context, rather than relying solely on image classification to identify animals and unlock chats [21]. This could allow the animal avatars to respond to visible behaviours, such as posture, movement, or feeding, making interactions more closely tied to the situated encounter with the real animal.

To reduce the risk of the animal avatars hallucinating factual information, we hard-coded key facts into their system prompts. However, this does not guarantee consistently accurate outputs. Preventing CAs from providing misleading or incorrect information is essential to ensure that users learn accurate facts about the animals. Future iterations could incorporate stronger quality-assurance mechanisms, such as expert validation or the integration of structured knowledge bases via techniques such as Retrieval-Augmented Generation (RAG) [15].

Lastly, while anthropomorphic personalities assigned to the animal avatars could contribute to engagement, they also risk oversimplifying or distorting perceptions of the animals’ natural

behaviours and conservation status [41]. Our evaluation solely focused on visitor engagement and experience; we did not assess learning outcomes or behavioural intentions related to conservation. Future work should investigate whether engagement with animal avatars translates into educational benefits or pro-environmental behaviour.

7 Conclusion

Infotainment technologies can support visitor experiences at zoos. In this paper, informed by prior work and two pilot studies, we designed and developed an LLM-powered mobile application: *Zoodex*. Our findings suggest that *Zoodex* supported visitor engagement among teenagers through interactive and entertaining content. Participants reported that chatting with animal avatars enhanced their sense of engagement with the zoo visit, though important questions remain about the implications of anthropomorphising animals through conversational AI. We expand on Webber et al.'s framework on engaging with nature through technology by proposing 'emulated interactions' as a conceptual lens for describing interactive applications that bridge physical environments with responsive digital representations.

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