COMP1649 Coursework

Human-Computer Interaction and Design

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1 Introduction

Human-computer interaction (HCI) consists of multidisciplinary fields of study that focus on the design of computer technology, especially the interaction between users and computers. This system aims to improve human-computer interaction by increasing the usability of computer interfaces. Usability is a chain of connections that changes according to social and cultural values. For this reason, user movements in this interaction are examined from different perspectives. This report aims to design a digital app for children in the UK to explore the animals, trees, and plants of the forest. The app will help children connect more deeply with the natural world by encouraging curiosity and enhancing outdoor learning experiences.

The report comprehensively analyses the design and development process for an educational app for children structured around key themes. It begins with a review of relevant HCI research and theory to inform the app's design. This is followed by a detailed description of the conceptual design, highlighting key features and the application of HCI principles. It then presents the mid-fidelity Axure prototype, including screenshots and details of the design process. A proposal for an empirical study is included to evaluate the app's usability and engagement. Finally, the conclusion reflects on the completed work, discusses its limitations, and offers suggestions for future development. This structure ensures a thorough exploration of the app's design process and its alignment with HCI principles.

2 Background literature

Designing a tablet application for children requires a comprehensive understanding of Human-Computer Interaction (HCI) principles, especially as they pertain to educational interfaces for children. This section reviews pertinent HCI studies, focusing on user needs and behaviours in children's learning and exploration and how existing solutions have informed the app's design requirements.

2.1 HCI Research

Digital tools encouraging outdoor exploration can bridge the gap between technology use and nature engagement. Kawas et al. investigated the use of the NatureCollections app among tweens (ages 8-12) and found that such tools can successfully engage children in outdoor activities while providing educational value *(Kawas, 2021)*. The app successfully promotes outdoor exploration, curiosity, and family bonding through shared activities like photographing and classifying nature. In contrast to typical screen-time worries, parents enjoyed these experiences. However, they also pointed out difficulties balancing privacy, autonomy, and screen-time regulations. The other paper explores how technology can enhance children's engagement with nature through HCI. It highlights three approaches: instructional tools like augmented reality to support outdoor science learning; exploratory technologies such as GPS-based games that encourage playful interaction with nature; and contributory platforms like Project Noah, which involve children in citizen science to build environmental awareness *(Anggarendra, 2016)*. The study highlights tools fostering lasting connections to nature, inspiring my app's focus on instructional, exploratory, and contributory technologies. Features like augmented reality enable children to scan and learn about trees and animals. Another study examines how interactive design in picture books impacts preschool children's reading experiences, focusing on emotions, preferences, and engagement *(Wang, 2020)*. Positive interaction forms, such as "touch and smell" and "pull/push," enhance interest and evoke happiness, while poorly designed interactions can lead to frustration. Designs like "puzzle" and "rotate" hold children's attention the longest, while conventional page-flipping is the least engaging. The research emphasises the importance of aligning interaction forms with sensory experiences and children's cognitive abilities to foster positive emotions, sustained interest, and better understanding, offering key insights for designing engaging picture books. The findings emphasise the importance of interactive features like sensory and action-based elements in boosting children's engagement and learning.

Inspired by these insights, the app I design incorporates nature scanning, bright colours, simple text, and gamified quizzes to foster curiosity, sustain attention, and provide an accessible, enjoyable learning experience that connects children with nature. Chen et al. present a framework for designing children's apps that enhance emotional experiences. By analysing 72 apps, it identifies design elements like interactivity, gamification, clear goals, feedback, and scaffolding, which foster joy, anticipation, and trust (Chen, 2022). These elements improve engagement and app ratings, providing developers with guidelines to create enjoyable, emotionally enriching apps for children. Inspired by these, my digital app aims to combine features that promote joy (exploring nature), anticipation (progress tracking, quizzes), and trust (intuitive feedback and guidance), ensuring both cognitive and emotional needs are addressed. In this way, the app meets the need for motivational tools that maintain a child's focus while reinforcing learned concepts.

2.2 HCI Theory

The children's nature exploration app for ages 6-12 is guided by established human-computer interaction (HCI) theories and concepts. This section discusses relevant HCI theories, including Don Norman's principles, cognitive load theory, interaction design patterns, and cognitive psychology, and how they apply to the app's development. There are many products around us that we have difficulty using or do not understand how they work. While some of the problems we experience with these products are due to human errors, most problems are due to poor design. Good design should be based on the principles of human-centred design. Don Norman describes the basic principles of human-centred design in his book "The Design of Everyday Things," which is considered a classic in the field of user experience (Norman, 1988). There are six principles by Don Norman:

- *Visibility: Key elements should be visible, clarifying possible actions.*
- *Feedback: Users should receive immediate feedback after performing an action, indicating success or failure.*
- *Affordances: Design elements should suggest their usage (e.g., buttons look pressable).*
- *Constraints: Limit options to reduce user errors and make the interface easier to use.*
- *Consistency: Design elements (e.g., buttons, icons) should be uniform across the interface to aid recognition.*
- *Mapping: The relationship between controls and their effects should be logical and intuitive.*

Interaction design emphasises creating interfaces that allow seamless communication between users and systems (Preece, 1994). For children, this involves designing simple, intuitive interactions that align with their developmental stages and minimise cognitive load. Cognitive load theory suggests that information processing should be simplified to prevent overwhelming users. This is particularly critical for children, as they have limited working memory capacity compared to adults (Sweller, 1988). The app reduces cognitive load by using clear icons, straightforward navigation, and interactive elements that guide children through tasks like identifying trees. Tasks are broken into smaller, manageable steps, ensuring children remain focused and engaged. Cognitive psychology principles are crucial in tailoring the app to children's developmental needs. The app incorporates short, focused activities like identifying a tree or solving a quick puzzle, keeping children engaged without requiring prolonged concentration.

Children interact with technology differently compared to adults, favouring intuitive modes of interaction like touch and sound. Research by Anthony and Brown highlights that children prefer touch-based inputs due to their simplicity and immediate feedback (Anthony, 2013). While the primary mode is touch-based, future enhancements could integrate voice interactions to allow children to ask questions about nature or receive verbal feedback from the app, further enriching the user experience.

Design Guidelines and Patterns Design patterns for children's educational applications often emphasise simplicity, engagement, and safety. For example, using bright colours, large touch targets, and intuitive navigation aligns with established guidelines for children's interfaces (Nielsen, 1994). The app needs to use bright colours, straightforward typography, and engaging animations to capture the attention of young users while maintaining readability. Navigation paths need to be designed to be simple and direct. For instance, after identifying a tree, a back button allows users to return to the home screen without confusion. Consequently, integrating these HCI theories and principles ensures that the app meets the needs of its target audience. This theoretical foundation will continue to shape the app's prototype and future iterations.

3 Product Design

3.1 Conceptual Design

The proposed app is a tablet-based digital tool designed for UK children aged 6–12 to explore and learn about nature. It focuses on identifying plants, animals, and trees commonly found in wooded areas. The app emphasises interactive learning through gamified features and sensory-rich activities to engage children in outdoor exploration. This design aims to foster curiosity and environmental awareness while maintaining a simple and child-friendly interface. Its design draws heavily on established HCI principles, such as Don Norman's visibility and feedback guidelines, and cognitive psychology concepts, such as cognitive load minimisation and developmental appropriateness. The app offers three main features to support children's exploration of animals, trees, and plants in the woods:

3.1.1 Main Tasks

- *Nature Identification: Using the tablet's camera, children can scan objects in their environment, such as plants, trees, and animals. The app identifies the object and provides fun, age-appropriate facts, enhancing the learning experience.*
- *Route Mapping: Using an interactive map, the app lets children track their exploration routes. Paths taken are displayed visually, and children can mark specific locations they are interested in.*
- *Gamified Challenges: The app incorporates quizzes and mini-games to encourage children to identify specific items in nature or complete tasks, such as "Find five oak trees".*

3.1.2 Key Assumptions for User Interaction and Behaviour

- *Ease of Interaction: Children prefer intuitive interactions, so the app relies on simple touch-based inputs like tapping, dragging, and swiping. Interactive elements, such as buttons and icons, are designed to align with natural affordances (e.g., a camera icon for scanning).*
- *Short Attention Span: Activities will be designed to be engaging and concise, ensuring children remain interested without becoming overwhelmed.*
- *Curiosity-Driven Behaviour: Children are naturally curious about their surroundings. The app is designed to leverage this curiosity by presenting educational information in engaging and accessible ways.*
- *Motivation Through Gamification: Badges and rewards encourage exploration and learning, motivating children to interact more with nature.*
- *Parental Involvement: Features such as tracking routes and viewing progress can be shared with parents, fostering family engagement and addressing concerns about screen time.*

3.1.3 Interaction Types

- *Touch Interaction: The app's primary interaction mode allows children to explore nature by tapping buttons, dragging markers, and swiping through information cards.*
- *Feedback Mechanisms: Instant feedback, such as animations and sound effects when a plant or tree is identified, ensures children remain engaged and understand the outcomes of their actions.*
- *Progress Tracking: A visual progress bar or collection log motivates users to continue exploring and learning.*
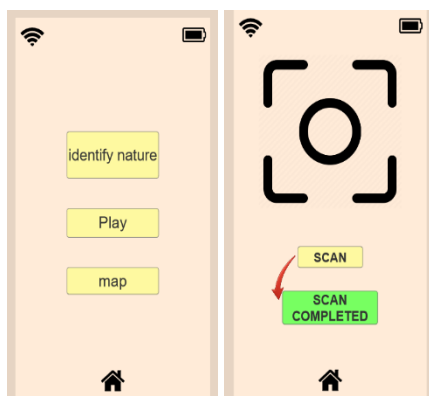
These are simple examples of home screens with three main features and identify nature screens. The application will also contain many icons. Metaphors and icons are crucial in creating engaging interfaces, particularly in applications geared toward children or nature enthusiasts. Here is some icon list example that I can use for my prototype:
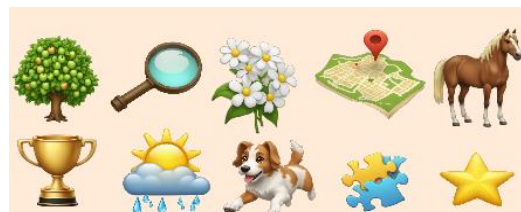
3.2 Design Principles

The app integrates Don Norman's design principles, which are seamlessly embedded into the design to align with the developmental needs of the target audience. This section discusses how visibility, feedback, consistency, constraints, and affordance are implemented and is supported by specific examples.

1. Visibility: *The app design features large, clear buttons with recognisable icons. For instance, the "Identify Nature" button uses a magnifying glass icon, making its function clear. Similarly, the "Map" and "Play Game" buttons are visually distinct and easy to use, ensuring intuitive navigation.*

2. Feedback: *The app provides immediate feedback to reinforce actions and enhance engagement. For example, after scanning a tree, users will go to the results screen to see which tree was Identified and with interesting facts about it.*
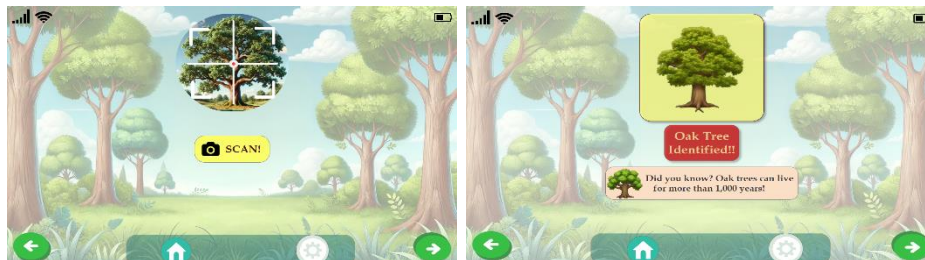
3. Constraints: *The app simplifies navigation by limiting features on each screen to avoid confusion. For example, the route recording screen displays only essential controls like the "Go" and "Stop" buttons, ensuring clarity. Actions like saving progress are automated to reduce steps for children.*

4. Consistency: *The app ensures consistency through uniform button shapes, fonts, and colours across all screens, making navigation predictable and manageable. The design layout remains the same on every page, helping children quickly grasp the interface.*

5. Affordance: *The app uses intuitive design elements to guide usage, such as the "SCAN" button featuring a camera icon to encourage tapping for scanning objects. Buttons are styled with a raised appearance, indicating they are interactive and can be pressed.*

6. Mapping: *The app uses natural mapping to make navigation intuitive, with features like the "MAP" button for route recording paths and buttons like "discovery" and "add discovery". Logical layouts, such as placing "SCAN" first, guide users, while pins and lines on the map help children visualise their journey.*

4 Prototype

The mid-fidelity Axure prototype was developed to test the proposed app's usability, interaction flow, and overall functionality. The prototype simulates the app's core user journeys, offering a hands-on experience for testing and refinement. This prototype aims to evaluate how effectively children can navigate the app, interact with its features, and complete tasks aligned with the conceptual design.

4.1 Process

- **Initial Design:** *The prototype began with a background focused on user flow and screen transitions. The layout emphasised simplicity and child-friendly elements. Icons, colours, and button sizes were arranged to ensure alignment with visibility and affordance principles.*
- **Iterations:** *During initial testing, navigation issues, such as unclear button labels and redundant steps, were identified. These were addressed by revising labels and streamlining pathways. Early versions lacked clear feedback and results mechanisms. Icons or fun facts were added to enhance engagement and reinforce actions. Non-essential features were removed to maintain focus and minimise cognitive load, ensuring age-appropriate usability.*
- **Problem-Solving Approaches:** *Logical flow adjustments guided children intuitively from one feature to another, such as placing "SCAN" first on the home screen. Icons and text sizes were tested for readability and adjusted to ensure screen consistency.*

4.2 Screenshots

1. Loading Screen: *The loading screen showcases a vibrant nature theme with deer and flowers, setting the tone for outdoor exploration. Users can move the home page by clicking start.*
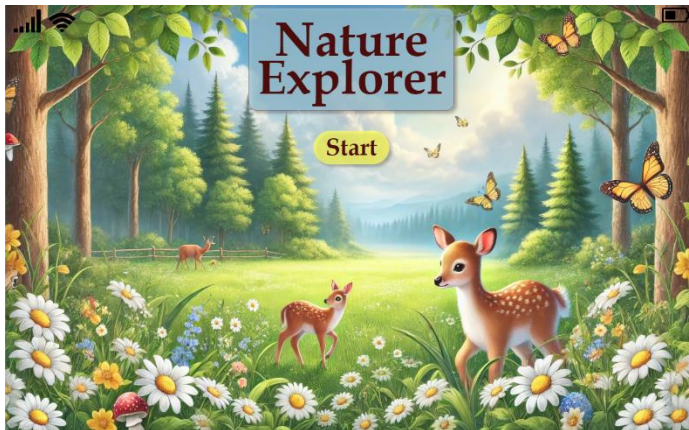
2. Home Screen: *The home screen features three large, colourful buttons: "Identify Nature," "Map," and "Play Game," with clear icons for intuitive navigation.*
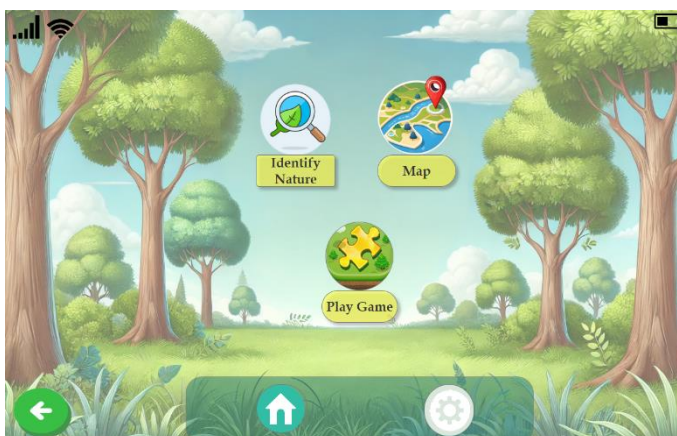
3. Identify Nature and Results Screen: *The Nature Identify screen features a live camera interface with a prominent 'SCAN' button, allowing children to identify objects seamlessly. The Result screen provides immediate feedback with the identified object, accompanied by fun facts to engage and educate children.*
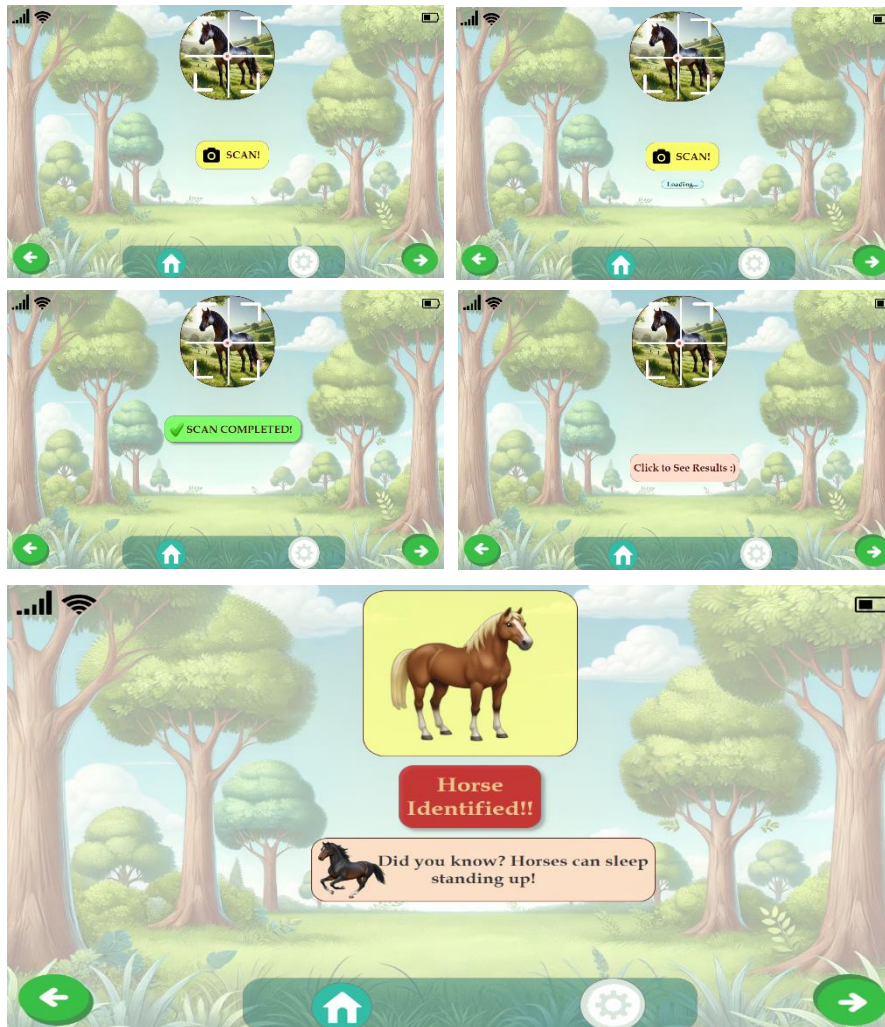

4. Map Screen: *The map screen allows children to track their exploration routes, view a list of discoveries, and add new findings to their exploration log.*

5. Route Recording and Results Screen: *The Route Recording screen allows children to start a timer with 'Go,' track their journey with moving footprints on the map, and stop the timer with 'Stop' to view detailed results.*
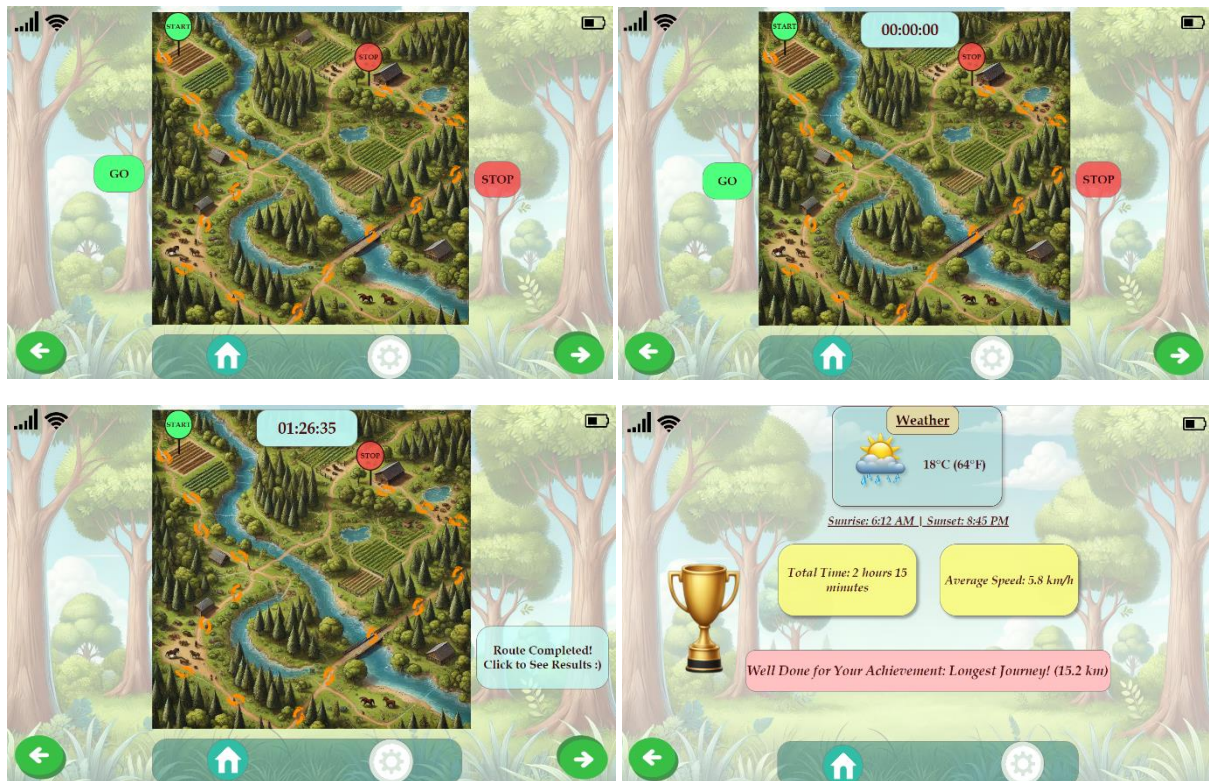
6. Play Game Screen: *The Play Game screen provides feedback for answers, encouraging children to try again if they are incorrect and rewarding correct answers with a positive message and visual reinforcement.*
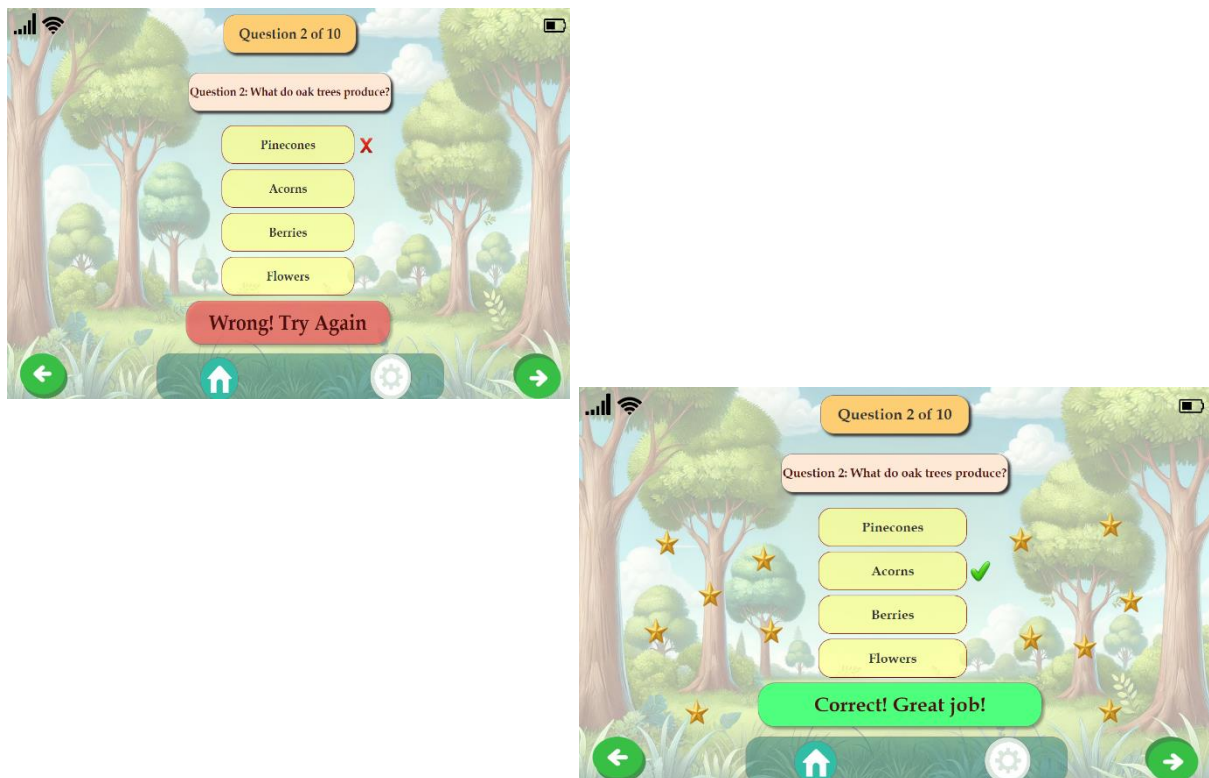
5 Research Study

The research study aims to evaluate the app prototype's usability, user engagement, and overall educational value.

5.1 Research Question and Hypothesis

- **Research Question 1:** *Does the app effectively engage children in exploring and learning about nature?*
- **Research Question 2:** *Are the app's features (e.g., nature identification, quizzes, route tracking) intuitive and easy for the target audience?*
- **Hypothesis:** *The app will enhance children's (6-12) engagement with nature by providing intuitive, accessible and interactive features (e.g., nature identification, quizzes, and route tracking) that foster curiosity and learning. They will be able to complete the main tasks with minimal guidance.*

5.2 Participants

20 children aged 6–12, with varying levels of exposure to technology and nature-related activities. Participants will be selected through local schools, youth organisations, and parental networks. Parents will be required to complete consent forms for their children to participate. Efforts will be made to choose a diverse group of participants regarding gender, location, and prior exposure to educational apps.

5.3 Methodology

1. Setup: *The study will be conducted in a controlled environment, such as a school computer lab or a community centre. Each session will last 30–40 minutes and include three predefined tasks: scanning a plant or animal, tracking a route, and completing a quiz. All interactions will be conducted using the mid-fidelity Axure prototype on a tablet.*

2. Data Collection: *Researchers will observe children interacting with the app, noting their ease of navigation, responses to feedback, and overall engagement. The percentage of tasks completed without assistance will be measured, and the time taken to complete each task will be recorded as an indicator of usability. Participants will complete a simple, age-appropriate post-session questionnaire to rate their experience with various app features. Short interviews with children and their parents will capture qualitative feedback on usability, educational impact, and overall enjoyment.*

3. Analysis:

- **Quantitative Analysis:** *Responses from questionnaires (e.g., Likert-scale ratings of navigation and enjoyment) will be analysed using descriptive statistics.*
- **Qualitative Analysis:** *Observational notes and interview responses will be coded to identify recurring themes, such as common usability issues or features children find most engaging.*

The combined data will be used to refine the app and address potential areas of improvement.

5.4 Materials

The study will require the following materials:

- **Consent Form:** *A detailed form for parents to permit their child's participation, addressing ethical considerations.*
- **Observation Sheet:** *This is a template for recording user behaviours, challenges, and notable interactions with the app.*
- **Sample Questionnaire:** *A child-friendly questionnaire with Likert-scale and open-ended questions to gather feedback on the app's features and usability.*
- **Interview Guide:** *A set of structured questions for post-session interviews with children and their parents.*

The research study will engage the target audience in a structured evaluation, providing actionable insights into the app's usability and engagement. This will ensure that the app effectively meets the needs of its target audience and encourages a deeper connection to nature. The findings from this study will directly inform future iterations of the app.

6 Conclusion

Designing the Nature Explorer app prototype was highly educational. Initially, I struggled to find a starting point, but once I began, I found it enjoyable and engaging. I felt fulfilled by the feeling of creating something that could positively impact children's learning and outdoor experiences. Despite initial challenges, the process yielded valuable results in user-centred design and HCI principles. The project showcased strengths but had limitations; as a newcomer to Axure, I struggled with some interactive features. For instance, I could not fully integrate a dynamic feature that would update the user's discovery list in real time as they added discoveries. The app assumes children aged 6–12 will intuitively navigate its features, but testing may reveal unexpected digital literacy challenges. Besides these, the mid-fidelity prototype lacks advanced features like gamification (e.g., leaderboards, collaboration), voice interaction for accessibility, and adaptive content for varying skill levels. The Next steps for development include a dynamic discovery list; gamification features like badges and rewards, and voice recognition for engagement and accessibility. Parental monitoring tools and collaborative modes boost interaction and safety. Consequently, the project demonstrated the potential of integrating technology with outdoor learning to create engaging educational experiences for children. The Nature Explorer app can evolve into a dynamic tool that fosters curiosity and knowledge and inspires a lasting connection with the natural world, strengthening children to explore and cherish their environment.

References

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Appendices

1 Search Strategy

- **Databases Used:** *Google Scholar, IEEE Xplore, ACM Digital Library, and ScienceDirect.*
- **Search Terms:**
  - ➢ *"HCI principles in educational apps for children"*
  - ➢ *"Gamified learning for kids"*
  - ➢ *"Interactive nature exploration tools"*
  - ➢ *"Cognitive load theory in app design"*
  - ➢ *"Usability in child-centred interface design"*
  - ➢ *"Don Norman Design Principles"*
  - ➢ *"Cognitive load theory"*
  - ➢ *"Nature digital app for children"*
  - ➢ *"What is human-computer interaction"*
  - ➢ *"HCI digital app for children "*

2 Study Materials

- **Consent Form:**

Participant Consent Form

Study Title: Usability Testing for Nature Explorer App

Purpose of the Study: This study aims to evaluate the usability and engagement of the Nature Explorer app designed for children aged 6–12 to explore and learn about nature. Your child will interact with the app and complete simple tasks. Observations and feedback will help refine the app to make it more engaging and user-friendly.

Your Rights:
- *Participation is voluntary.*
- *You or your child can withdraw at any time without any consequences.*
- *Data collected during the study will remain confidential and anonymised.*

What Your Child Will Do:
- *Use the app to perform three activities: identification of nature, tracking a route, and completing a quiz.*
- *Sessions will last 30–40 minutes and include a brief questionnaire.*

Parental Consent:
I agree to let my child participate in this study. I have read the information provided and understand the purpose and procedures involved.

Parent/Guardian Name: _____
Child's Name: _____
Signature: _____
Date: _____

- **Sample Questionnaire:**

Sample Questionnaire
_____

Usability Questionnaire for Children

Participant ID: _____
Date: _____

1. How easy was it to navigate the app?
[ ] Very Easy [ ] Easy [ ] Moderate [ ] Difficult [ ] Very Difficult

2. Did you enjoy using the app?
[ ] Very Much [ ] Somewhat [ ] Neutral [ ] Not Really [ ] Not at All

3. What did you like most about the app?
_____

4. What did you find difficult or confusing?
_____

5. Would you like to use this app again? Why or why not?
_____

- ***Observation Sheet:***

Observation Sheet

Participant ID: _____
Date: _____

Task 1: Identify Nature (Scan Feature)
- ***Time Taken***: _____
- ***Ease of Use***: [ ] Very Easy [ ] Easy [ ] Moderate [ ] Difficult [ ] Very Difficult
- ***Errors Observed***: _____
- ***Notable Behaviours***: _____

Task 2: Route Mapping
- ***Time Taken***: _____
- ***Ease of Use***: [ ] Very Easy [ ] Easy [ ] Moderate [ ] Difficult [ ] Very Difficult
- ***Challenges Faced***: _____
- ***Notable Behaviours***: _____

Task 3: Quiz Game
- ***Engagement Level***: [ ] Very High [ ] High [ ] Moderate [ ] Low [ ] Very Low
- ***Errors Observed***: _____
- ***Notable Behaviours***: _____

General Notes:
_____
_____
_____
_____

- ***Interview Guide:***

Interview Guide

Interview Questions for Children

1. What was your favourite feature of the app, and why?

2. Was there anything you found confusing or difficult to use?

3. How did you feel about the app's feedback, like messages or animations?

4. Is there anything you would like to add to make the app more fun?

Interview Questions for Parents

1. How do you feel about the app's educational value?

2. Do you think the app is easy for children to use independently?

3. Were there any features that you felt were particularly effective or ineffective?

4. Do you see this app as something you'd encourage your child to use outdoors?