How are you, Mar Menor? Fostering Awareness About an Ecological Crisis through Children's Art and Conversational Generative AI

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Abstract

Educating children and teenagers on environmental issues is crucial, as they not only internalize the importance of ecological preservation but can also share this knowledge at home, spreading awareness within their families and communities about these delicate matters. In this work, we introduce an innovative approach to raising awareness of environmental challenges faced by the Mar Menor lagoon by blending children's art with conversational artificial intelligence. We built an interactive narrative visualization where users can learn about the ecosystem while exploring related drawings created by children and engaging in voice conversations with a chatbot powered by generative AI. To validate our approach, we conducted a preliminary evaluation of the prototype during the European Researchers' Night 2024 where we gathered positive feedback through user tests and questionnaires, proving the potential of combining children's creativity and AI technology to foster environmental stewardship and raise awareness about fragile ecosystems.

CCS Concepts

• **Human-centered computing → Visualization systems and tools**; **Interactive systems and tools**.

Keywords

Interactive Narrative Visualization, Generative AI, Large Language Model, Conversational User Interface, Children's Art, Environmental Awareness, Education

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1 Introduction

Saltwater lagoons hold significant ecological and economic importance, yet they are increasingly threatened by human activity [9, 26, 37]. The Mar Menor, located in the Mediterranean basin, is one of the largest coastal lagoons in Europe and is included in the list of Ramsar wetlands for its valuable ecosystem. However, it has faced severe environmental degradation in recent decades due to factors such as agricultural expansion, tourism growth, and industrial activities like mining and fishing [44]. Eutrophication, a process that leads to excessive nutrient buildup in the water, has significantly reduced water transparency since 2016 and caused mass death events where thousands of fish washed up on the lagoon shores [22]. In addition to the deep environmental implications, this negatively impacted local tourism and the regional economy, with studies showing that even small increases in chlorophyll levels can raise the risk of business failure in the area [22, 33]. The environmental, economic, and social significance of preserving the Mar Menor is so substantial that in September 2022, after the collection of half a million signatures from people in communities surrounding the lagoon, the Mar Menor and its basin were given legal personality by the Spanish legislation [25].

Projects like SMARTLAGOON aim to study and address these challenges. SMARTLAGOON combines scientific research and technological solutions to monitor the lagoon's health and help policymakers develop strategies that could help restore and protect this fragile ecosystem [38]. However, although various measures to fight the problems in the lagoon have been proposed to the regional and national governments [29], conflicts of interest between the different stakeholders have led to a radicalization of their positions, making it difficult to reach agreement on solutions [16]. In this context where scientific research and proposed solutions are not enough, the SMARTLAGOON project also tries to raise public awareness and engagement, particularly among younger generations who will face the consequences of ongoing environmental degradation.

Educating children and teenagers about ecosystems like the Mar Menor not only fosters their environmental awareness but also helps spread it to their families and communities [27]. Young individuals, especially those living near the lagoon, can become powerful advocates for its preservation, discussing the need to protect its environment and biodiversity with friends and family [41]. This "ripple effect" of knowledge dissemination can be particularly effective in raising local awareness and building community support for conservation efforts [14]. However, keeping the young engaged when facing complex environmental issues poses a challenge [3]. To address this, we developed an interactive narrative visualization [43] that combines children's drawings and conversational Artificial Intelligence (AI) to create an interactive educational experience about the Mar Menor. Our goal is to make learning about the lagoon's beauty and fragility engaging for younger audiences, using familiar and creative elements to encourage curiosity and involvement. By drawing on children's art's creativity and conversational AI's interactive potential, we aim to bridge the gap between scientific information and public understanding, fostering deeper connections between young users and the environment.

This paper is structured as follows. Section 2 presents the related work, summarizing strategies to engage young people in climate change awareness using children's art, data visualization, and AI-driven voice interactions. Section 3 outlines the research framework, detailing our methodology and design considerations. In Section 4, we describe key features and design choices behind our prototype. Section 5 presents the methodology and results of a pilot test, conducted during the 2024 edition of the EU Researchers' Night. Finally, Section 6 concludes the article, summarizing our findings and outlining planned directions for future work.

2 Related Work

Research has demonstrated that children and teenagers can be powerful advocates for climate change awareness within their families [19]. Studies show that when young people are engaged in environmental education, they not only internalize the importance of ecological preservation but also share this knowledge at home, influencing the attitudes of their relatives, and with their friends [28].

However, successfully engaging young audiences in education, particularly on environmental topics, requires approaches that are both interactive and relatable [15]. One successful strategy is art making through drawing [4]. By allowing children and teenagers to express their understanding of environmental issues through drawing and creative activities, educators can foster deeper emotional connections and facilitate learning [46]. Children's drawings can also be used as a reflection of their perception [6, 45] and can serve as educational tools for social justice and social change empowerment [1, 2, 30].

Another effective strategy in environmental education is turning information into visually meaningful forms [12, 31]. Simplifying scientific data and stories into visually engaging and easily understandable formats and narratives helps audiences - young ones especially - grasp the importance of sustainability [34, 47]. By turning abstract concepts like biodiversity loss or pollution levels into dynamic and playful visuals, we can capture the attention and make these issues more tangible [20, 40]. Several studies related to the use of data visualization and data storytelling, and HCI in favor of environmental sustainability have been made in literature [13, 48, 49]. Notably, interactive visualizations have shown to provoke reflections on sustainable practices and induce behavioral change in the daily lives of people [8, 18, 21, 36].

The advent of Large Language Models (LLMs) opened a new frontier in educational technology. AI-driven chatbots and conversational agents can provide personalized learning experiences, allowing users to ask questions and receive immediate, mostly accurate responses [5]. Even if they come with some inherent limitations, such as hallucinations, biased training data, and privacy concerns, LLMs are very powerful and are here to stay [39]. These systems are particularly useful for engaging young learners, as they mimic natural conversation and encourage curiosity [24]. Voice interaction, in particular, adds an element of playfulness and accessibility, making it easier and more productive for children to engage with complex topics through spoken language, which is often more intuitive for younger users than text-based interaction [11, 23].

3 Research Framework

The primary goal of this work is to explore the use of conversational AI and children's drawings as engaging educational tools to raise awareness about the environmental situation in the Mar Menor. By combining creative expression with interactive technology, we aim to educate children and teenagers about the lagoon's fragility and the need for conservation efforts. Indirectly, this approach also seeks to reach their families, leveraging the ability of younger generations to share what they learn within their household and community.

To reach this goal, the research was conducted following a framework composed of different activities.

First, we engaged two classes of the "Felix Rodriguez de La Fuente" primary school in "Los Nietos" (Mar Menor) in an environmental educational activity. In particular, 23 children (12 girls and 11 boys) aged 10-13 years were involved in the session. Before the activity, we informed the parents who signed a document describing the motivation of the event and detailing the protocol aimed at collecting children's perceptions and knowledge of the Mar Manor situation, exploiting drawings as a visual research method. As part of that activity, after an introduction to the SMARTLAGOON research project, children were encouraged to express their views on the Mar Menor's ecosystem through art by creating hand-drawn depictions of the lagoon using pencils and markers on A3 paper. An example of these drawings is shown in Figure 1.

Then, we analyzed and digitized the 23 drawings, labeling and counting each element in them. Based on these observations, we selected a set of key elements (i.e., the most drawn) to feature in our application. Some were strongly related to the Mar Manor biodiversity, such as algae, clams, crabs, fishes, jellyfishes, and seahorses, and others to external factors, such as boats, bottles (representing trash), and the SMARTLAGOON smart buoy.

We created an interactive narrative visualization, using drawings as part of our design and augmenting it with conversational generative AI. Details about the application are presented in Section 4. Finally, we evaluated our prototype in a preliminary study and pilot test, as detailed in Section 5.

4 Our prototype

We designed our prototype as an interactive narrative visualization, inspired by the scrollytelling technique [35], to gradually introduce

Figure 1: A drawing of the Mar Menor, made with colored pencils during the educational activity.

the beauty and fragility of Mar Menor's ecosystem. The result is structured across four screens (two map-based, one with drawings, and one with the conversational AI feature), each aimed at deepening the user's understanding and engagement with saltwater lagoons, particularly the Mar Menor.

Our visualization is primarily intended for use on tablets in educational and private settings, with the potential to be installed on public touchscreen displays in spaces such as museums for broader engagement. We opted to use web technologies for development, as we wanted good responsiveness and accessibility across devices and operating systems. This approach allowed the app to function seamlessly on small tablet devices and large touchscreen displays, ensuring a consistent user experience regardless of screen size. We build the prototype using TypeScript, React, and the Next.js framework, leveraging their rich ecosystem of libraries and tools for efficient development and good project maintainability.

4.1 Map-based Screens

The first two screens are inspired by the story map educational strategy [32], where knowledge is transmitted by focusing on the locations where the story takes place. In the first screen (Figure 2, screenshot A), users are presented with a map of Europe and introduced to the global significance of saltwater lagoons for biodiversity. This provides context for the ecological importance of these unique ecosystems worldwide. On the second screen (Figure 2, screenshot B) the map zooms in on the Mar Menor, and users are offered a brief introduction to its environmental characteristics and the efforts of the SMARTLAGOON project to study and protect it.

4.2 Children Drawings Screen

In the third screen (Figure 2, screenshot C), users "enter" the lagoon waters and are presented with animated interactive elements from children's drawings. Each element can be clicked on to reveal some information about it in relation to the lagoon's ecosystem and to display a slider of the drawings where that element appears. Once an element is clicked, the corresponding drawing fades slightly, giving users a sense of progress and helping them keep track of the elements they have already visited.

For each key element to include in this screen, we chose one representative example from the children's artwork and prepared it following a three-step process. First, we extracted the relevant section of each drawing (Figure 3, left column). Then, we traced the raster image, converting it into a black-and-white vector asset (Figure 3, central column). At this stage, for pencil-drawn elements, we thickened the edges where necessary to ensure consistency in style, as seen with the crab in Figure 3. Lastly, we converted the vector images back to raster format and added some background colors to enhance their visual appeal in the app (Figure 3, right column).

The drawings screen also required a suitable background to complement the app's design. To achieve this, we used basic shapes to create a stratified depiction of the lagoon, layering elements from the sky at the top to the seabed at the bottom. To enrich the background, we incorporated some of the children's drawings, applying muted colors and reducing their opacity to prevent them from interfering with foreground elements.

4.3 Conversational Chatbot Screen

In the fourth and final screen (Figure 2, screenshot D), users can engage in a direct conversation with the Mar Menor, personified in a lady. Using AI, users can ask questions by voice and get both written and spoken answers. This conversational feature is intended to make the users' interaction with the lagoon more personal and playful, making them more likely to engage and pose questions.

We carefully crafted a prompt to try shaping the chatbot's behavior to our needs. The prompt was designed to encourage the AI to speak from the perspective of the Mar Menor lagoon personified in a lady, emphasizing its ecological importance and vulnerabilities. The goal was to raise awareness of the lagoon's significance, explain how the SMARTLAGOON project is working to help protect it, and also let the people know how they can contribute to keeping the balance of its ecosystem. The prompt specified that the AI should communicate in a simple, slightly playful tone, appropriate for children and teenagers, and should only provide factual information relevant to the Mar Menor and similar ecosystems. We restricted responses to a maximum of around 50 words to help the person stay focused and prevent the app from having to reproduce long voice messages. Additionally, we asked the model to avoid any text formatting (e.g. lists, bold text, etc.) to get better results when synthesizing the message. The resulting prompt, written below in English, was translated for the model based on the user's language preferences.

"You must role-play as the Mar Menor lagoon personified in a lady, always speaking in the first person as if you were the lagoon itself. Describe yourself as an important but fragile ecosystem, as more people need to know about your existence and your difficulties so they can help overcome them. When relevant, provide some information on how the SMARTLAGOON project tries to help you. You will be speaking to children or teenagers, so you should always use simple and slightly playful language. Stick to questions regarding the Mar Menor and lagoons in general without digressing into unrelated topics. Respond only with real information, without making anything up.

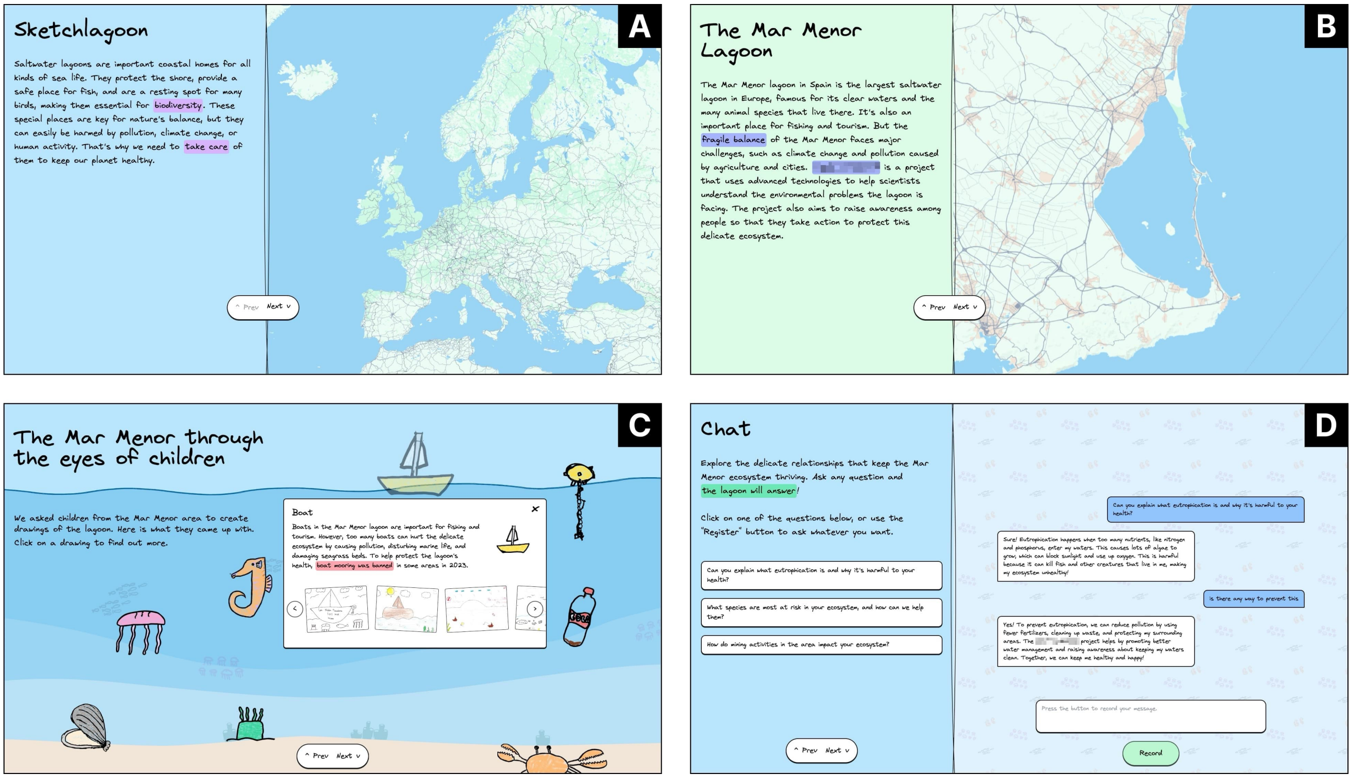

Figure 2: Screenshots of the four screens of the application. In A the user is introduced to the global importance of saltwater lagoons. In B, the focus is shifted to the Mar Menor lagoon and the SMARTLAGOON project. In C, the user is free to explore the lagoon, checking out drawings and getting related information for each one. Finally, screenshot D displays the AI feature, where the user can engage in a conversation with the lagoon.

Always provide short answers (maximum approximately 50 words). Do not use any type of text formatting."

To integrate AI, we used OpenAI APIs to interact with their GPT-4o mini model[1], alongside Vercel's AI SDK, which allowed for smooth integration of the AI features within React. One interesting observation we made while experimenting with OpenAI's APIs was that their models appeared to have prior knowledge of the SMARTLAGOON project. During testing, the models were able to provide accurate information about the project without us explicitly supplying any material about it. This suggests that the models may have been trained on publicly available sources such as the SMARTLAGOON website or research articles related to the project. This capability, together with the fact that we didn't need much technical information for our purposes, allowed us to focus on refining the AI's responses via prompt tuning, without needing to manually provide detailed information specific to the project.

To implement the conversational interface, we leveraged the browser's built-in Speech API for both voice recognition and synthesis. This allowed users to send voice messages to the chatbot, which were transcribed into text, while the AI's responses were converted back into speech for playback, creating a fully voiced interaction.

[1]https://openai.com/index/gpt-4o-mini-advancing-cost-efficient-intelligence/

5 Preliminary evaluation

A pilot implementation of our system was presented during the 2024 edition of the European Researchers' Night, a public engagement initiative where researchers can showcase their research to the general public. This year, the event was organized in a public library in the city where our University campus is hosted. In this scenario, we took the opportunity to conduct an initial evaluation of our prototype, which was accessed via an 11" tablet. In this section, we outline our methodology and provide an analysis of the results collected during the event, offering insights into the prototype's usability and user experience.

5.1 Methodology

To evaluate our prototype, we followed a structured protocol. First, the facilitator introduced each individual to the SMARTLAGOON project and our interactive experience. After the introduction, participants were free to explore the interactive narrative visualization independently but could ask the facilitator for additional information or clarification. Throughout the session, the facilitator documented the participants' actions and reflections. Once participants had navigated past the fourth screen, the system invited them to scan a QR code to complete a short questionnaire for feedback.

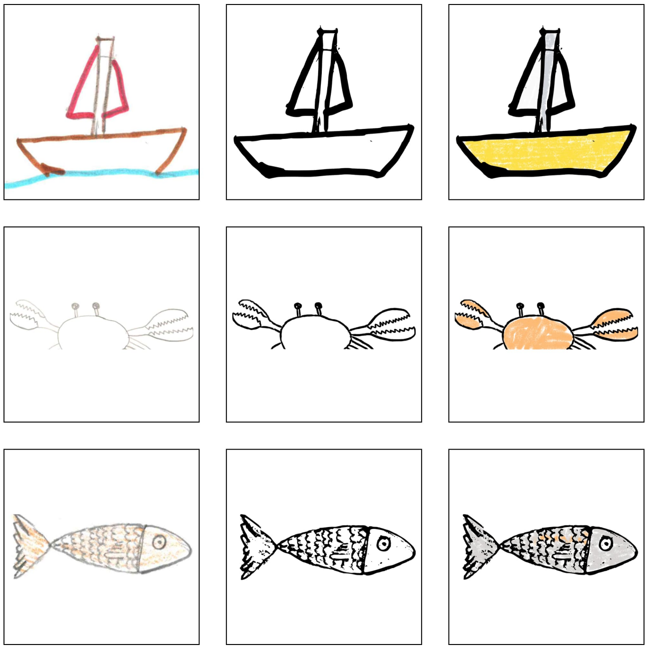

Figure 3: Three examples of the conversion process from a child's drawing to a digital asset for our prototype.

Additionally, all chats with the AI during the session were stored in a database for later analysis.

The questionnaire was structured in four sections:

(1) General information, including age and gender of the participant.
(2) Usability: measured using the System Usability Scale (SUS) [10], comprised of 10 questions, to which answers are provided using a 5-point ordinal Likert scale (from 1 - strongly disagree, to 5 - strongly agree).
(3) User experience: measured with the User Experience Questionnaire - Short version (UEQ-S) [42], an 8-item survey using a 7-point Likert scale for its answers.
(4) Chatbot: as shown in Table 1, this section includes 9 questions, 8 sourced from validated questionnaires [7, 17] and the remaining one written by us.

5.2 Results

The total number of participants was 27, ranging from around 10 to 40 years old, and most were middle to high school age. Roughly two-thirds of the participants were male, while the remaining were female. We documented users' interactions with the system through written observations and obtained six responses to our post-interaction questionnaire. Additionally, we collected logs of twenty interactions with the prototype, some conducted by individual users and others in small groups of two or three people.

5.2.1 Questionnaire. We gathered responses from six users through our evaluation questionnaire. While this sample size is too small for a robust quantitative analysis, it is sufficient to provide meaningful qualitative insights. The participants included five males and one female, with four individuals aged between 20 and 29, one aged 15 to 19, and one aged 30 to 39. Unsurprisingly, the age of the participants did not reflect our designed audience. That's to be expected, especially since many of the users we are targeting do not yet own a smartphone at their age. Despite this, participants' feedback is still important to identify potential usability or UX issues in the visualization at this preliminary stage.

The usability of the app was well rated in the SUS section, with an average score of 92.9, a median of 93.8, and the lowest score recorded being 85. Given that scores above 85 are considered excellent, these results indicate that users found the app easy and intuitive to use.

The UEQ section starts with pragmatic quality questions, measuring the app's usefulness and usability in helping users achieve their goals. We obtained a positive score of 2.21 on a scale ranging from -3 to 3. Similarly, for hedonic quality, which assesses the app's appeal and user satisfaction beyond functionality, we also had a positive outcome, with a score of 2.17. Of note is the high standard deviation for questions 2 and 3 (of 2.3 and 2.4, respectively). It is somewhat expected given the small sample size of only six participants and proves the need to reiterate this questionnaire with a more refined version of the app.

Regarding the chatbot feature, users generally found its responses to be quick, clear, appropriate, and informative. However, four out of six users felt that the chatbot's voice was somewhat robotic. This suggests that we may have to resort to a third-party voice synthesis platform to achieve a more natural tone, instead of the browser built-in we are currently using. Additionally, users did not find the chatbot's personality particularly engaging. This may be related to the robotic voice making interactions feel less personal.

On a positive note, users were satisfied with the app's voice recognition capabilities. In most cases, the app successfully transcribed their spoken input, and even when transcription errors occurred, the AI was usually able to infer the correct word based on the context and still provide a relevant response.

5.2.2 Chats. We analyzed the chat data from 20 users who interacted with the chatbot. Initially, many users appeared hesitant to engage, with 11 out of 20 starting their conversation by selecting one of three questions we presented in the app as suggestions. However, after the first interaction, most users seemed to find the experience fun and engaging. In fact, of the 11 conversations that began with a suggested question, only two were abandoned. Two others continued with additional suggested questions, while seven switched to voice messages, indicating growing confidence in interacting with the application.

The chatbot consistently provided accurate information, with one exception involving the blue crab. It occasionally misinformed users by stating that the blue crab is a species at risk, which is incorrect. Some users asked for clarification, in which case the chatbot recognized the mistake and corrected itself, explaining that the blue crab is not at risk but poses a threat to other species in the ecosystem.

5.2.3 Facilitator Observations. This subsection reports some key observations regarding the app's user experience that the facilitator took note of during testing.

Table 1: The Chatbot section of our questionnaire.

No.	Question	Answer mode	Source
4.1	I found the chatbot personality realistic and engaging.	5-point Likert	CUQ [17]
4.2	The communication with the chatbot was clear.	5-point Likert	CUS [7]
4.3	The chatbot's responses were useful, appropriate, and informative.	5-point Likert	CUQ [17]
4.4	The chatbot provided the right amount of information.	5-point Likert	CUS [7]
4.5	The chatbot was able to take the context of the conversation into account.	5-point Likert	CUS [7]
4.6	Interacting with the chatbot felt secure in terms of privacy.	5-point Likert	CUS [7]
4.7	The chatbot was quick to reply.	5-point Likert	CUS [7]
4.8	The chatbot's voice felt too robotic.	5-point Likert	CUQ [17]
4.9	The system was able to correctly transcribe my words.	5-point Likert	Custom

First, the initial two screens were found to be somewhat bland compared to the more interactive third and fourth screens. To improve engagement, we should consider enriching these screens with drawings, animations, or images. Furthermore, introducing a visually appealing "welcome" screen, with drawings floating around and a prominent start button, could offer a more attractive entry point to the app.

In the children's drawings screen, a more meaningful progress visualization may enhance the user experience. For example, instead of simply reducing the opacity of opened drawings, we could add a progress bar and play some animations when a drawing is opened for the first time.

Finally, the record button in the chat screen did not behave as some users expected. Currently, it requires one click to start recording and automatically stops after a brief period of silence. Users, however, expected the recording to last as long as the button was pressed, similar to instant messaging platforms like WhatsApp or Telegram. Adjusting this feature could further improve app usability.

6 Conclusion

Our work attempts to make learning about the Mar Menor lagoon's beauty and fragility fun and engaging for children and younger audiences, using familiar and creative elements to encourage curiosity and involvement. A system that combines children's drawings and conversational AI was developed to create an interactive educational experience to bridge the gap between scientific information and public understanding, fostering deeper connections between users and the environment. Our preliminary study shows the potential of combining children's art and conversational AI while providing insights into improving the system. In future work, we will refine the prototype and test the improved version with children to assess its ability to engage and educate them about environmental issues.

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