Reflections on GreenBot: An AI-Powered Platform for Sustainability Education

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Insights

- Five AI experts within GreenBot provide distinct learning experiences across a wide variety of environmental topics.
- Modular architecture supports multiple LLMs through API integration, avoiding vendor lock-in as technologies develop.
- Expert systems like GreenBot can offer more relevant sustainability guidance than general-purpose chatbots, supporting the goals of sustainable human-computer interaction.

Sustainability dilemmas are everywhere. Picture yourself in a retail store comparing two items. One features excessive plastic packaging. The other carries a steep premium solely for its organic seal. Which one do you choose? Later, you might catch yourself counting the seconds of use for a hallway light versus a kitchen pendant, wondering if every bulb needs an LED upgrade to save the planet. Such choices are rarely simple to cope with. Even with a proliferating amount of online information, making sustainable decisions and choices remains a quandary. Seemingly inconsequential choices, such as deciding between two coffee cups, become noticeable burdens, sometimes psychological ones, when clear guidance on systemic trade-offs is lacking.

Downstream from such decision conundrums, a clear disconnect exists in how we teach sustainability to students. Whether in school or at a university, the difficulty seems to be not so much that people lack environmental awareness or the good will to act in accordance with sustainability, but rather that the daily friction of translating sustainability intent into practice is overwhelming. People often face too much broad

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information, with too little actionable guidance for decision-making. Consequently, good intentions too rarely turn into reality.

To facilitate sustainable decision-making, researchers in fields such as sustainable human-computer interaction are actively working on technologies to bridge this good intentions-behavior gap. GreenBot,[a] a specialized sustainability system that leverages AI experts for sustainability assistance, represents one effort to solve such issues. Instead of relying on a single all-purpose expert, it provides five specialized sustainability experts to assist users with sustainability queries in different domains, including biodiversity, waste management, energy efficiency, climate change, and sustainable consumption (Figure 1). The AI experts operate within defined boundaries, producing tailored information for students and others interested in more-sustainable lifestyles. Each AI expert maintains a unique voice without working in isolation. GreenBot simply hands the conversation to the relevant AI expert as users' questions change from one domain to another.

GreenBot provides sustainability instruction that is necessary at every level of education. For example, future business leaders have to take ecological care into consideration alongside business growth [1]. Creating viable sustainable business models requires balancing ecological responsibility with economic feasibility [2], and product designers and developers need to learn about sustainable production technologies. People need practical knowledge to make environmentally sound decisions in daily life. Educational initiatives that explicitly link coursework to the United Nations Sustainable Development Goals have been shown to deepen understanding

a https://www.greenbot.live/

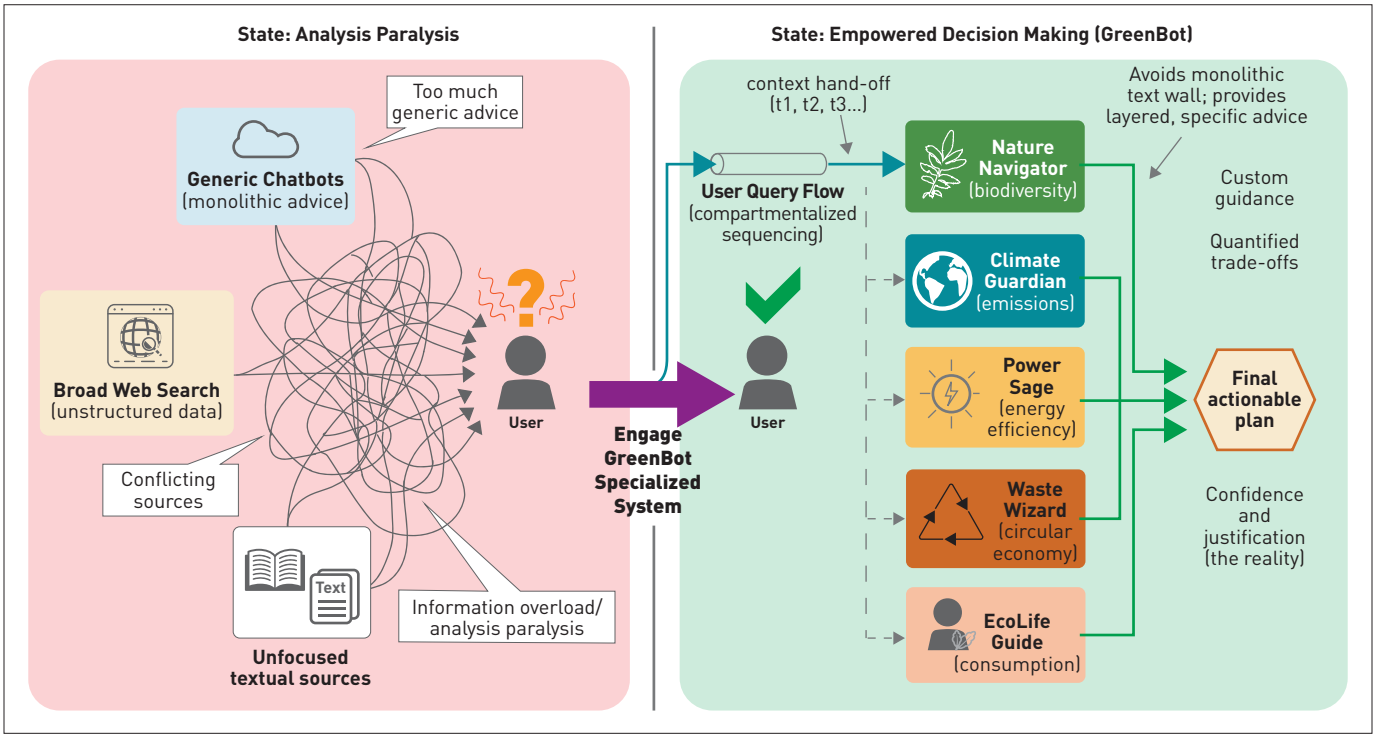

Figure 1. Generic information sources leave users overwhelmed and directionless. GreenBot's five domain experts replace that confusion with sequenced, expert guidance.

and engagement [3]. In the greater scheme of things, GreenBot focuses on higher-education students and professionals learning to embed sustainability into organizational practices, though its user-friendly design supports learners across all educational backgrounds.

In this article, we make the case for specialized AI in sustainability education. We will first explain why five focused experts outperform a single generalist. We then trace how a student moves through three of them to build a real action plan. Finally, we look at what this means for educators bringing sustainability into the classroom.

WHY FIVE AI EXPERTS INSTEAD OF ONE?

What changes when you engage with five different AI experts acting in sequence instead of a single expert? GreenBot's experts each operate under a system prompt designed to shape their specific expertise and approach. More specifically, Nature Navigator focuses on biodiversity and ecosystems; Waste Wizard instructs the user about circular economy and resource efficiency; Power Sage centers on energy systems and renewables; Climate Guardian provides information about emissions; and EcoLife Guide helps manage sustainable lifestyle choices.

General-purpose chatbots such as ChatGPT can answer questions about forest conservation or solar panels, but the responses tend to cover everything at once. Ask Nature Navigator the same forest question and the answer stays within ecological balances, skipping the economics and policy tangents. Ask Power Sage about solar panels and the focus holds on efficiency and payback periods. The framing is narrower by design, and that narrowness is the point. The user gets domain-relevant guidance rather than a broad sweep of loosely related information.

There is a subtler benefit too. When users know that they are interacting with a Waste Wizard, it shapes how they think and what they ask. Questions become more focused and relevant. A student who knows they are talking to a Waste Wizard starts asking sharper questions, moving from "What should I do about plastic?" to "Can ocean plastics work as a construction material?"

FOLLOWING ONE QUESTION ACROSS THREE EXPERTS

To understand how this works in practice, consider a fictitious student, Anna, developing a sustainability strategy for a professional coffee shop project as part of her university classwork. Anna begins with Climate Guardian to find a definite measure of the shop's carbon footprint. The AI expert identifies that energy use takes about 40 percent; refrigeration adds 25 percent; supply transport accounts for 20 percent; and waste management is 15 percent (these are illustrative figures). Refrigeration is the clearest place to start, because it's large enough to move the needle and concrete enough to act on. Climate Guardian identifies that refrigerators contribute through both direct refrigerant leaks and high electricity load. From here, Climate Guardian suggests Power Sage as the better expert for what comes next. Anna follows that prompt for specifics. Energy Star units promise 20 to 30 percent power savings, and a financial analysis shows the investment would pay for itself in roughly four years. Power Sage then flags a concern about packaging and points Anna toward Waste Wizard, which handles that domain (Figure 2).

The student moves to Waste Wizard, now carrying context from the earlier exchanges. The conversation turns to disposable cups. Waste Wizard clarifies that compostable materials are not inherently better if the local infrastructure cannot process them. The city's composting program

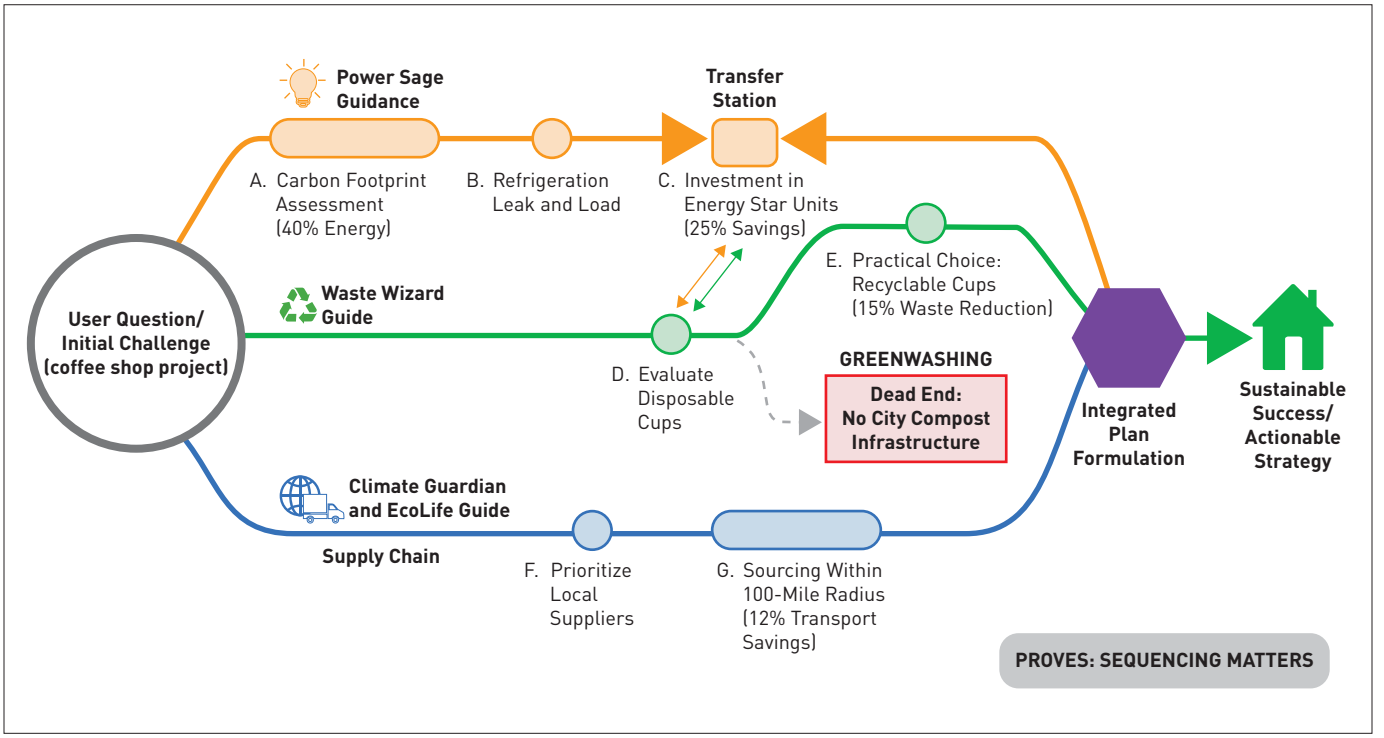

Figure 2. A student's coffee shop sustainability query moves sequentially through Climate Guardian, Power Sage, and Waste Wizard, each building on prior context to produce an integrated action plan.

accepts only organic remains; it does not take tableware. As plausible as the compostable label may seem, disposable cups would end up in landfills without breaking down properly. Given such a reality, recyclable cups are the more practical choice for the coffee shop.

Based on these three discussions, the student has a plan. Anna will replace the main refrigerator within two years to cut emissions by 25 percent and switch to recyclable cups immediately to reduce landfill waste by 15 percent. She will prioritize local suppliers within a 100-mile radius to cut transport emissions by 12 percent. When Anna's professor asks for a justification, she speaks confidently. What matters in this example is not the volume of information, it's the sequencing. Rather than getting generic advice, Anna received focused guidance on refrigeration efficiency, waste infrastructure, and supply chain decisions.

WHEN SPECIALIZATION MEETS CULTURAL SENSITIVITY

While AI can deliver information, technical queries sometimes demand more than mere data; they require cultural sensitivity. For example, when students ask Nature Navigator about incorporating Indigenous forest knowledge into sustainability practices, the AI expert acts in deference to heritage structures. It provides guidance on building alliances with native groups, following respect protocols, and managing every segment of the discussion steps. It suggests combining ancestral environmental wisdom with empirical research (Figure 3).

GreenBot's experts are designed to recognize when a question carries cultural weight. A generic chatbot given the same query tends to flatten the complexity, offering a tidy summary that misses what makes the question difficult in the first place.

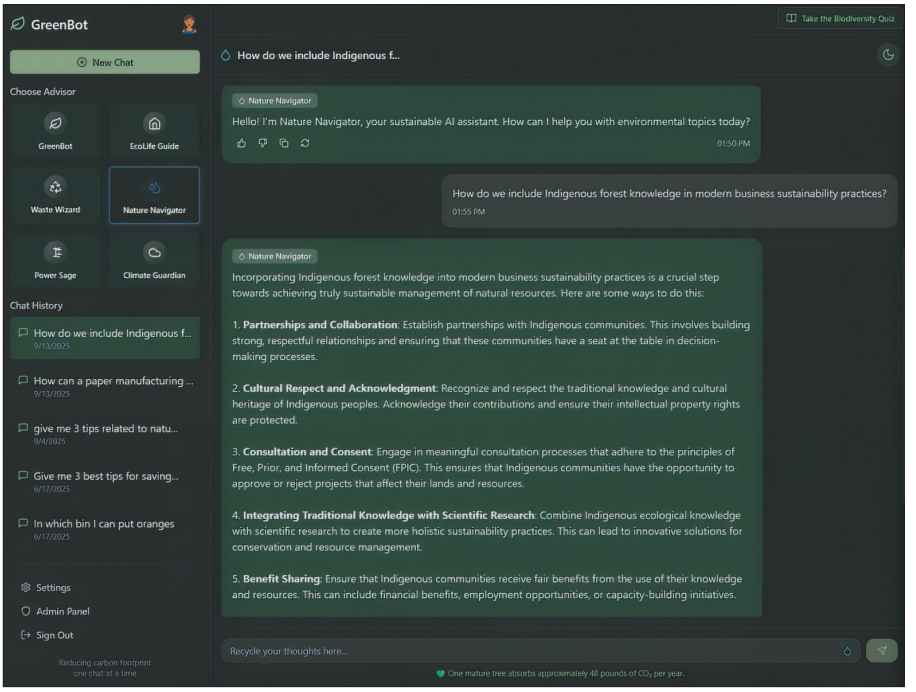

Figure 3. Nature Navigator response to Indigenous knowledge query, demonstrating layered advice rooted in cultural awareness through alliances, respect protocols, and scientific integration of heritage.

Nature Navigator flags what should not be assumed and guides the student toward a careful, considered approach rather than a quick answer.

SPECIALIZATION IN ACTION

The versatile nature of specialized AI is best seen through precise support. For example, if you are worried about monarch butterfly populations in your community garden, Nature Navigator helps you plan pollinator habitats. It recommends native plant species that grow in mixed cycles, such as milkweed in June, asters in September, and goldenrod in October. This guarantees habitat diversity by including both nectar sources and larval host plants. Nature Navigator also offers tips for scheduling garden maintenance to avoid disturbing chrysalis formation.

For a homeowner evaluating a heat pump, Power Sage analyzes efficiency markers inside different climate zones and calculates break-even points based on installation costs versus heating bill reductions over a decade. When planning a low-carbon business trip, Climate Guardian shows a stark contrast: Traveling by train produces 80 percent fewer emissions than flying; driving produces 60 percent more emissions than the train. Specialized guidance handles both scenarios with ease. The effectiveness of specialized AI is revealed when the user receives data anchored in their specific environment.

BUILDING THE SPECIALIST SYSTEM

GreenBot is software built on React and TypeScript plus Vite for the front end, delivering a clean and responsive interface. The backend relies on Supabase for information storage and user-side authentication, with the full system hosted on Vercel. Though the technology stack enables functionality, the real value lies in the tailored learning experiences it supports and the adaptability to evolve alongside advances in AI. At the core of the platform are the five specialized AI experts (Figure 4). Each operates based on a structured system prompt with four elements: core knowledge areas defining their domain (e.g., forest ecology for Nature Navigator, circular economy for Waste Wizard), communication style shaping how information is delivered (practical for Waste Wizard, urgent yet hopeful for Climate Guardian), main responsibilities outlining instructional roles, and constraints pointing out that responses rely on credible sources and recognize uncertainty. This systematic logic transforms a general AI model into a focused domain expert.

The platform also features self-assessment quizzes for each environmental topic (Figure 5). Research shows educational chatbots are more effective when paired with assessment tools [4]. The quizzes help learners identify knowledge gaps and monitor progress. With each question, people receive immediate feedback and explanations, reinforcing understanding as they track their development over time. This approach recognizes our present ability to ensure assessment is continuous rather than periodic.

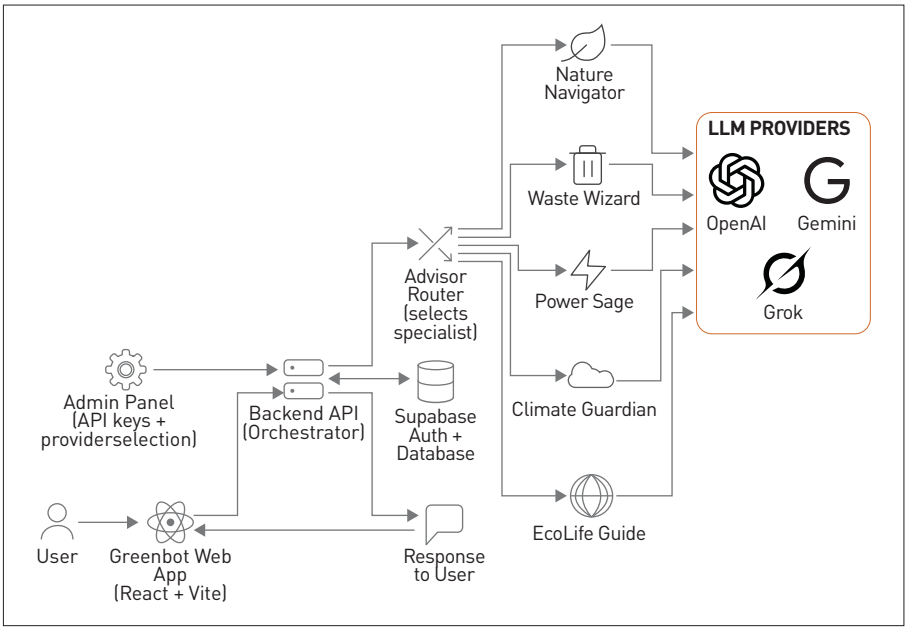

Figure 4. GreenBot's system architecture: admin panel for API management, multi-AI backend (OpenAI/Gemini/Grok), five specialized experts with custom prompts, and student interaction modes.

FLEXIBLE DESIGN FOR SWITCHING BETWEEN AI PROVIDERS

Modular design becomes useful when managing differences in model capabilities across providers. Through the admin panel, educators and administrators can manage API keys for multiple AI providers (OpenAI, Gemini, and Grok) and switch between language models as needed (Figure 6). This flexibility allows institutions to test new models or shift providers based on performance, cost, or access, avoiding dependence on any single company's platform. Such flexibility is a plausible strategy for maintaining educational quality as AI technology evolves.

Users can personalize their experience through adjustable settings. Options include switching between light and dark themes, enabling environmental impact tracking to view sustainability metrics, managing notification preferences, and setting up automatic conversation saving. The settings page also displays the currently active AI provider.

PRACTICAL APPLICATIONS FOR EDUCATORS

Educators can integrate GreenBot into teaching in several practical ways. Students can be assigned to experts suited to course topics, such as Nature Navigator for conservation units or Climate Guardian for climate change modules. Educators can also create scenario-based assignments where students consult experts to develop solutions for local ecological problems and use quizzes to measure knowledge growth before and after a unit.

The dilemmas students can bring to GreenBot tend to be the ones that resist easy answers: Is a heat pump worth the up-front cost in a cold climate? Which local plants best support pollinators through the growing season? How much does cutting one long-haul flight actually matter for a personal carbon

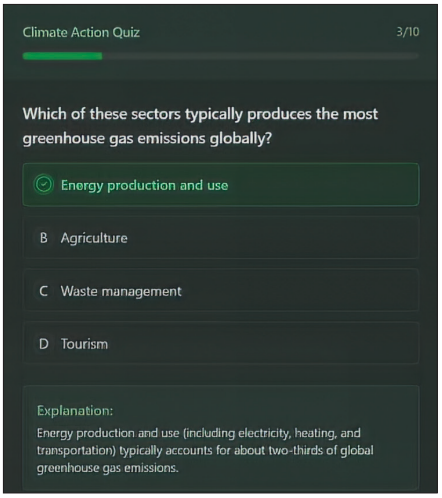

Figure 5. Climate quiz interface with multiple-choice questions, explanation of correct answers, progress tracking, and navigation controls.

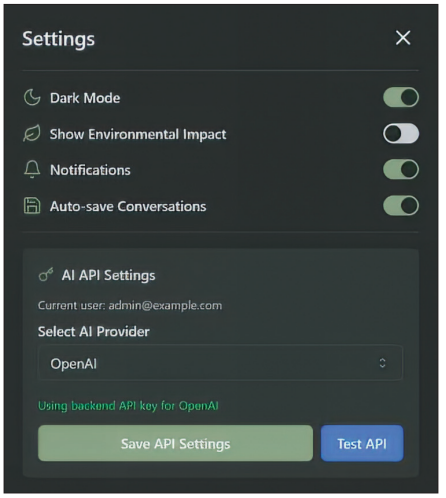

Figure 6. User settings interface with theme toggle, environmental impact metrics, notification preferences, autosave options, and AI provider selection.

footprint? Each question has a natural home in one of the five experts.

Perusing chat logs helps educators identify areas where learners face challenges and may need additional support, revealing interesting patterns in how students approach sustainability problems. For example, an instructor might notice that students consistently struggle to understand the difference between direct and indirect emissions in refrigeration, allowing for an apt classroom intervention. GreenBot is a fully functional web application accessible to everyone, from middle school students to college students in engineering, public policy, and business programs.

LOOKING AHEAD

The main challenge of sustainability chatbots like GreenBot is not technical; it is adoption. In the greater scheme of things, educational institutions need time to put new AI tools into curricula. This kind of thinking poses hidden dangers if we assume that software solves every pedagogical hurdle. GreenBot fills a pressing need in sustainability education by combining specialized experts with interactive tools [4].

Effective education in this field also means supporting learners as they work through emotions such as eco-anxiety, hope, and discouragement, all of which affect engagement and motivation [5]. Still, improvements are possible. Upcoming updates will focus on refining the prompts for each expert, creating new sustainability scenarios, and enhancing self-assessment functions. These changes will be guided by feedback from educators and students using the platform in real-world teaching environments.

Tools such as GreenBot can support sustainability learning when designed with apt educational settings and accessibility in mind [4]. Leveraging multiple AI experts reflects the importance of varied philosophical lenses and different viewpoints in environmental education [6]. Future work will explore integrating the system with learning management platforms to make it easier to adopt in formal education. The goal is to help people move beyond awareness and make informed, actionable choices.

The gap between knowing and doing in sustainability will not close on its own. But with specialized AI guidance, scenario-based learning, and accessible tools, environmental literacy can become more practical and attainable. GreenBot is not meant to replace teachers or environmental educators; it is designed to be a readily available resource for anyone facing a sustainability quandary.

The GreenBot system serves everyone from university students untangling a perplexing recycling issue to professionals navigating the conflicting demands and needs of corporate sustainability. Our present ability to advance hinges on the feedback emanating from learners who use these tools to drive their actual daily decisions. The central question remains whether we can design AI that helps people apply environmental knowledge to their everyday decisions, turning global sustainability awareness into localized action.

References

1. Azmat, F., Lim, W. M., Moyeen, A., Voola, R., and Gupta, G. Convergence of business, innovation, and sustainability at the tipping point of the sustainable development goals. *Journal of Business Research 167* (2023), 114170.
2. Bocken, N. M. P., Short, S. W., Rana, P., and Evans, S. A literature and practice review to develop sustainable business model archetypes. *Journal of Cleaner Production 65* (2014), 42–56.
3. Manolis, E. N. and Manoli, E. N. Raising awareness of the Sustainable Development Goals through ecological projects in higher education. *Journal of Cleaner Production 279* (2021), 123614.
4. Chang, C.-Y., Hwang, G.-J., and Gau, M.-L. Promoting students' learning achievement and self-efficacy: A mobile chatbot approach for nursing training. British *Journal of Educational Technology 53*, 1 (2022), 171–188.
5. Skilling, P., Hurd, F., Lips-Wiersma, M., and McGhee, P. Navigating hope and despair in sustainability education: A reflexive roadmap for being with eco-anxiety in the classroom. *Management Learning 54*, 5 (2023), 655–679.
6. Tryggvason, A., Öhman, J., and Van Poeck, K. Pluralistic environmental and sustainability education: A scholarly review. *Environmental Education Research 29*, 10 (2023), 1460–1485.

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