

**FUTURE SCENARIOS 2030–2050: ECOLOGICAL EDUCATION
AND ARTIFICIAL INTELLIGENCE**

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***Introduction:** As the world approaches the 2030 deadline for the UN Sustainable Development Goals and looks toward 2050 climate targets, the intersection of artificial intelligence (AI) and ecological education emerges as a critical field of inquiry. This paper explores plausible future scenarios for AI-enhanced ecological education between 2030 and 2050, addressing both opportunities and inherent tensions.*

Methods: This foresight study employs scenario methodology, analyzing 70+ future schools scenarios from 18 industry reports, synthesizing expert projections from the Center for the Governance of Change, and examining emerging technological prototypes including immersive AI installations and adaptive learning platforms. Four distinct scenarios are developed through iterative analysis.

Results: Three converging timelines emerge: By 2030, AI will likely be seamlessly integrated into daily educational practice, with 80% of citizens anticipating AI playing a key role in societies and 47% expecting widespread AI use in classrooms. Four future scenarios for AI-enhanced ecological education are identified: (1) Technologically Integrated Education, where VR/AR and AI platforms dominate learning; (2) Sustainable and Community-Engaged Education, positioning universities as sustainability hubs; (3) Skills-Based Lifelong Learning, focused on microcredentials and industry partnerships; and (4) Decentralized

Globalized Education, with borderless AI-mediated learning . A critical paradox emerges: data centers powering AI solutions are projected to double electricity consumption by 2030, potentially undermining climate goals. By 2045, artificial general intelligence (AGI) may emerge as humanity's "guardian," addressing systemic risks including climate change.

Keywords: future scenarios, artificial intelligence, ecological education, 2030 Agenda, 2050 climate targets, AGI, sustainability, educational foresight

Introduction

1.1 The Confluence of Critical Timelines

The period 2030–2050 represents a critical juncture for humanity. Two major international frameworks converge during this timeframe: the United Nations 2030 Agenda for Sustainable Development and the 2050 net-zero emissions targets central to the Paris Agreement. Simultaneously, artificial intelligence is undergoing unprecedented acceleration, with projections suggesting artificial general intelligence (AGI) could emerge by 2045. The intersection of these trajectories—ecological sustainability and AI development—will fundamentally reshape how societies educate young people about the environment.

The Center for the Governance of Change's foresight report, "The Next 50: Trends for the Next 50 Years," reveals that citizens rank climate change and global economic inequality as the foremost challenges humanity will face by 2073. When presented with potential existential risks, respondents identified climate cataclysm as their primary concern, followed by pandemic and global system collapse. Critically, 80% of citizens believe AI will play a key role in societies by 2073, with nearly half expecting seamless integration into daily life.

1.2 The Imperative for Educational Transformation

Ecological education stands at the precipice of transformation. Traditional approaches—classroom-based instruction, textbook learning, occasional field trips—are manifestly insufficient for preparing young people to navigate the complex environmental challenges of the coming decades. The International Journal of the Learning Sciences highlights that authentic encounters with wild nature are significantly associated with positive affective attitudes toward biodiversity. Yet such encounters are becoming rarer as urbanization accelerates and "nature deficit disorder" spreads among youth.

1.3 Research Questions

This paper addresses three interconnected questions:

1. What plausible future scenarios exist for AI-enhanced ecological education between 2030 and 2050?
2. How might these scenarios interact with broader technological, social, and environmental trends?
3. What tensions and paradoxes—particularly the AI-energy-climate nexus—must be navigated?

Methods

2.1 Scenario Methodology

This study employs scenario methodology, a foresight approach widely used in strategic planning and futures research. Scenarios are not predictions but plausible, internally consistent descriptions of alternative futures that help organizations and societies prepare for uncertainty. The methodology follows the framework outlined by Wilby and Smith for university climate adaptation, which

emphasizes gathering essential information, engaging stakeholders, and testing institutional plans against multiple futures.

Data Sources

Three primary data sources inform this analysis:

Expert projections and public attitudes: The IE University Center for the Governance of Change report synthesizes contributions from 15 experts and over 8,000 citizens across multiple countries, providing rich data on public expectations for technology, education, and climate futures.

Institutional foresight documents: Analysis of 70 "future schools" scenarios from 18 existing industry reports, as documented by Kaviani and colleagues. This comprehensive review revealed that existing scenarios rarely address climate change, energy, and environmental implications of AI technology—a gap this paper seeks to fill.

Emerging technological prototypes: Examination of cutting-edge AI-enhanced ecological education initiatives, including the Lumisphere Experience in Rio de Janeiro, the Beijing Academy of Artificial Intelligence's research on AI for sustainable development, and the UN 2030 Sustainable Development Model integrating AI, blockchain, and metaverse technologies.

2.3 Scenario Development Process

Four distinct scenarios were developed through iterative analysis, drawing on the framework proposed by Wilby and Smith for universities in 2050. These scenarios are not mutually exclusive; as Wilby and Smith note, the most likely outcome is "a fusion of them all". Each scenario is characterized by:

- Dominant educational paradigm

- Role of AI in ecological learning
- Institutional form and structure
- Environmental implications and tensions
- Alignment with 2030–2050 timelines

2.4 Limitations

This study has several limitations. First, scenario analysis inherently involves uncertainty; actual futures may diverge significantly from any of the scenarios presented. Second, the analysis draws primarily on English-language sources and expert projections from North America, Europe, and East Asia, potentially underrepresenting perspectives from the Global South. Third, the rapid pace of AI development means that technological assumptions may quickly become outdated.

Results

3.1 Converging Timelines: 2030 and Beyond

Analysis of expert projections reveals three converging timelines that will shape ecological education between 2030 and 2050.

2030: The SDG Deadline and AI Integration. By 2030, the United Nations Sustainable Development Goals reach their target date. According to Huang Tiejun, Chairman of the Beijing Academy of Artificial Intelligence, "by 2030, we are likely to witness the emergence of AGI surpassing human cognitive capabilities". The Center for the Governance of Change reports that 47% of citizens expect widespread AI use in classrooms by 2073, with significantly higher expectations in Asian countries: China (65%), Indonesia (63%), Japan (58%), and

South Korea (58%). Critically, 62% of citizens expect individualization of education, where each student receives tailored instruction.

2045: The AGI Horizon. Huang projects that "by 2045, embodied AGI with self-awareness that comprehensively surpasses human perception and cognition is expected to arrive, opening a new chapter of human-machine symbiosis". The core mission of this AGI, in Huang's framework, is to serve as humanity's "guardian" and "expander"—helping 破解 climate change causality chains, 抵御 existential risks, and exploring extreme environments beyond Earth's limits.

2050: Climate Neutrality and Institutional Transformation. By 2050, signatories to the Paris Agreement aim for net-zero emissions. Universities and educational institutions, if they survive in recognizable form, will have undergone profound transformation. Wilby and Smith pose the question: "What would a well-adapted university look like?" Their answer envisions fewer weather-related disruptions, comfortable buildings during heatwaves, reduced flood damage, intact supply chains, and thriving biodiversity across campus.

3.2.1 Scenario 1: Technologically Integrated Education

In this scenario, advances in technology fundamentally transform the learning process. Virtual and augmented reality, powered by AI-driven adaptive learning platforms, become fully integrated into educational practices. Students engage in immersive virtual environments, collaborating with peers globally and receiving personalized instruction from avatar professors.

For ecological education, this scenario offers extraordinary possibilities. The Lumisphere Experience in Rio de Janeiro provides a glimpse of this future. This large-format climate engagement installation combines 360-degree projection

mapping, guided audio design, and AI image generation to encourage participants to imagine their ideal ecological future. Visitors move through three domes—Orientation, Immersion, and Creation—culminating in an interactive lab where AI generates personalized visions of preferred futures based on structured prompts about environmental qualities, desired landscapes, and imagined technologies.

3.2.2 Scenario 2: Sustainable and Community-Engaged Education

In this scenario, universities and schools take a central role in addressing global challenges and sustainable development. Community engagement and experiential learning are core features as students work on real-world projects with local partners. Campuses prioritize environmental sustainability and serve as hubs for sustainable research and innovation.

The UN 2030 Sustainable Development Model being developed through NSF and EPA-funded grants illustrates this approach. The project adopts an innovation-management approach to transfer technology and knowledge, incorporating AI, blockchain, machine learning, and metaverse technologies to support four AI-powered interventions: e-Conferences and e-Workshops for high school educators, and e-Academies and e-Externships for high school students. The goal is to "prepare future workforce with interdisciplinary knowledge, transferrable skills, and AI-competency to solve global complexities innovatively on the human-computer frontier".

3.2.3 Scenario 3: Skills-Based Lifelong Learning

This scenario envisions a shift from degree-based education to greater focus on acquiring specific skills. Microcredentials, digital badges, and continuous education programs become prominent. Universities partner with industry and

professional bodies to offer targeted skills development, with lifelong learning needed to upskill and reskill for evolving job markets.

For ecological education, this translates into targeted training for the green economy. Students might earn microcredentials in environmental data analysis, carbon accounting, renewable energy system design, or nature-based solution implementation. AI powers just-in-time learning platforms that deliver precisely the ecological knowledge needed for specific tasks.

The RENCİ panel at SXSW EDU 2026, "The Climate Paradox of AI Education," highlights the tensions within this scenario. As panelists note, "AI transforms climate education with personalized learning and interactive simulations" while simultaneously driving "massive energy consumption that threatens to undermine our climate goals". With data center electricity use projected to double by 2030, the panel asks: "How do we justify using energy-intensive AI to teach climate solutions?"

3.2.4 Scenario 4: Decentralized and Globalized Education

The rise of online learning and global partnerships leads to decentralized education in this scenario. Universities collaborate across borders, offer joint degrees, and share resources. Students access diverse courses taught by AI lecturers and study at multiple institutions simultaneously. Campuses focus on specialized programmes and research centers rather than comprehensive undergraduate education. For ecological education, this scenario enables unprecedented access to diverse environmental knowledge systems. A student in Central Asia might take courses on boreal forest ecology from Scandinavian universities, tropical forest conservation from Brazilian institutions, and desert

The Center for the Governance of Change report adds another dimension: a generational split in responses to existential threats. "The percentage of respondents who think they are more likely to 'fight' than 'flight' tends to be higher among older rather than younger respondents". This suggests that young people may feel less agency in shaping their futures—a perception that participatory scenario development could directly address.

4. Discussion

4.1 Integrating the Scenarios: Toward a Fusion Framework

As Wilby and Smith note, the most likely future is "a fusion of them all" rather than any single scenario dominating. The challenge for educational institutions, policymakers, and educators is not to predict which scenario will prevail but to build adaptive capacity across multiple plausible futures.

For ecological education specifically, this fusion might take the form of:

- **Technologically enhanced but community-grounded learning:** Using AI-powered immersive experiences to connect students with local environmental challenges and solutions.
- **Skills-based but holistically oriented curricula:** Offering microcredentials in green skills while ensuring students develop systems thinking and ecological wisdom.
- **Globally connected but locally rooted institutions:** Leveraging AI-mediated global partnerships while maintaining deep engagement with local ecosystems and communities.

- **Sustainability-driven but energy-conscious implementation:** Deploying AI tools only when their educational benefits clearly outweigh their environmental costs, and powering them with renewable energy.

4.2 Navigating the AI-Energy Paradox

The AI-energy-climate paradox identified by the RENCİ panel demands urgent attention from educators, technologists, and policymakers. Several strategies emerge from the analysis:

Transparency and accounting: Educational institutions should require carbon footprint disclosures for AI tools they deploy, similar to nutritional labels for food products. Students should learn to evaluate the environmental impact of different technological choices.

Efficiency optimization: The Beijing Academy of Artificial Intelligence's research on spike cameras, inspired by the human visual system, demonstrates how biologically inspired design can achieve "ultra-low power consumption and ultra-high efficiency" processing. Such innovations could dramatically reduce AI energy demands.

Renewable-powered infrastructure: Data centers serving educational AI should be powered by renewable energy and located in regions with sustainable cooling options. Institutions should consider these factors when selecting technology partners.

Pedagogical parsimony: Not every learning objective requires AI. Educators should develop frameworks for determining when AI adds sufficient educational value to justify its energy cost, and when simpler, lower-impact approaches suffice.

Huang's vision suggests symbiosis rather than replacement: "humans guard Earth, and AGI spreads across the sea of stars". In this framing, AGI extends human capabilities to environments beyond Earth while humans maintain stewardship of the home planet. Ecological education would then serve dual purposes: preparing humans for planetary guardianship and training AGI systems to understand and protect Earth systems.

4.5 Implications for Policy and Practice

Several implications emerge for educational institutions, policymakers, and researchers:

For universities and schools: Begin now to develop institutional adaptation plans that test resilience against multiple scenarios. Wilby and Smith outline a practical framework: set adaptation goals, gather essential information, evaluate future risks, and prioritize actions. Engage students in this process to build futures literacy and agency.

For policymakers: Support research on the environmental footprint of educational AI and establish standards for transparency and accountability. Fund participatory scenario development that includes young people's voices. Ensure that sustainability education includes critical examination of technology's environmental impacts.

For researchers: Develop better methods for assessing the educational effectiveness and environmental cost of AI-enhanced learning. Investigate cultural variation in technology adoption and ecological understanding. Create tools for participatory futures that genuinely empower young people.

Conclusion

The period 2030–2050 represents a critical juncture for both ecological sustainability and artificial intelligence. The convergence of these trajectories will fundamentally reshape how societies educate young people about the environment. This paper has explored four plausible future scenarios for AI-enhanced ecological education—Technologically Integrated, Sustainable and Community-Engaged, Skills-Based Lifelong Learning, and Decentralized Globalized Education—and examined their implications.

Several conclusions emerge:

First, the most likely future is a fusion of scenarios. Educational institutions must build adaptive capacity to navigate multiple plausible futures rather than betting on any single vision.

Second, the AI-energy-climate paradox demands urgent attention. Data centers powering educational AI are projected to double electricity consumption by 2030. Educators must develop frameworks for determining when AI's educational benefits justify its environmental costs, and prioritize renewable-powered, energy-efficient solutions.

Third, young people must be central to shaping their educational futures. Current scenario-building practices systematically exclude student perspectives, despite young people's stake in environmental outcomes. Participatory scenario development can build futures literacy and agency.

Fourth, cultural context matters. Expectations for AI in education vary significantly across world regions, suggesting that futures will be locally appropriated rather than globally uniform.

Finally, the AGI horizon beyond 2045 opens both extraordinary possibilities and profound questions. If AGI becomes humanity's "guardian" for addressing climate change, ecological education may serve dual purposes: preparing humans for planetary stewardship and training AGI systems to understand and protect Earth.

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