

**Visualizing Futures: Children's Co-created Sustainability Solutions
with Text-to-Image Generative AI**

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Abstract

This case study explores the potential of text-to-image generative artificial intelligence (AI) in fostering children's engagement with sustainability. While text-to-image generative AI has gained traction in creative fields, comprehensive studies examining its use with children—particularly for learning about sustainability—remain limited. Our research aims to contribute to bridging this gap by analyzing how Finnish 6th-grade children prompt generative AI to explore sustainability challenges, blending creativity, environmental awareness, and problem-solving. The study utilized text-to-image generative AI during an interactive exhibition of children's art focusing on children's visual expressions and hands-on activities regarding sustainability solutions. The prompts created by children ($N = 290$ groups, with each group consisting of two to five children) at the exhibit's AI station were collected and analyzed. These prompts, which the children used to generate visual representations of sustainability challenges and solutions, helped to complement the children's understanding of sustainability as part of their transdisciplinary STEAM learning process. Focusing on how text-to-image AI, as an emerging interactive technology, can enhance critical thinking and creativity in addressing sustainability issues, this case study offers insights into AI's role in encouraging students to imagine and visualize future sustainability scenarios. Findings suggest that text-to-image AI stimulates individual and collective creativity, enabling children to explore complex environmental concepts through technology-enhanced learning experiences. The study concludes with practical recommendations for child-computer interaction, integrating AI-driven tools in sustainability education, emphasizing transdisciplinary collaboration between children and technology, in the context of education for environmental sustainability.

Keywords: Text-to-Image Generation, Generative AI, Child-Computer Interaction, Environmental Sustainability, STEAM Education, Futures Literacy, Creative Learning

Highlights

- The educational program used fosters multiple literacies
- ES was the most often selected topic among 14 sustainability topics
- Solutions imagined by children were mostly artifacts as tools for change
- Children interacted fluently with generative AI
- Creative ways to interact with AI were intuitively conducted

Introduction

Generative AI is reshaping various facets of human life. Different generative AI solutions, such as text-to-image generation, are increasingly integrated across various fields. Generative AI is a novel paradigm (Dhar, 2024) employing foundation models (Bommasani et al., 2021). Foundation models have been trained on web-scale amounts of data (Oppenlaender, 2024) and, as a result, allow the conjuring of almost any information, including visual outputs in the case of text-to-image generative models. Text-to-image generation leverages AI to convert human-created ideas into visual representations (Coeckelbergh, 2023). This makes generative models ideal for supporting creativity during ideation (Oppenlaender, 2022). Since gaining widespread attention in 2022, it has been well-studied how adults interact with and use generative models (e.g., Oppenlaender, Linder & Silvennoinen, 2023; Lc & Tang, 2023; Xie et al., 2023; McCormack et al., 2024). However, research on how children interact and conceptualize with generative AI remains limited.

Thus, children's interactions with text-to-image generative AI have not yet been the focus of comprehensive studies, nor has there been significant exploration of the potential for generative AI to engage children in learning about sustainability. Although some generative AI solutions are designed with children in mind, they are often implicitly shaped for adult users, making accessibility and engagement for younger audiences a secondary consideration (Kender et al., 2020). Additionally, the role of interactive technologies in fostering children's understanding of environmental sustainability (ES) remains underexplored (Vasalou & Gauthier, 2023).

ES is one pillar of sustainability, alongside social and economic pillars (Giddins et al., 2001; Purvis et al., 2019). These three pillars—ES (e.g., conservation and responsible use of natural resources), social sustainability (e.g., human rights, social equity, inclusion, quality of life), and economic sustainability (e.g., economic growth through viable, resilient, and equitable systems)—are interdependent dimensions that support long-term human and planetary well-being (United Nations, 2015). However, existing research often focuses on a single pillar, commonly ES, or two pillars (typically social and ES), rather than all three (Vasalou & Gauthier, 2023). This tendency highlights the need for future Child-Computer Interaction (CCI) research to address all pillars and their interconnections, aiming for a more holistic approach to sustainability in educational technology design.

In this context, CCI research has a unique role in studying how interactive technologies influence children's learning and development. The core of CCI research involves designing and evaluating technologies specifically for children, while also examining broader societal impacts (Hourcade, 2015). In recent years, an important focus has emerged on designing not only for children but with children, particularly through creative participatory design methods (Lehnert et al., 2022). This approach aligns well with sustainability education, as involving children in the design process can enhance their engagement and ownership over their learning experiences.

According to a framework of environmental education strategies (Monroe et al., 2008), technologies can be instrumental in promoting ES learning by conveying information, fostering understanding, building skills, and supporting sustainable actions. The potential for integrating advanced technologies, such as generative AI, into educational settings represents a promising opportunity to foster a more comprehensive, creative, and future-oriented learning environment focused on sustainability. Further research is essential to understand how these technologies can be effectively employed to engage young learners in all three pillars of sustainability, supporting a holistic approach to education for sustainability.

Recently, AI literacy has started to be integrated into educational curricula (e.g., Su & Zhong, 2022). Children's conceptions of technology (Valguarnera et al., 2022) and AI (Mertala & Fagerlund, 2024) have been examined also to enable the development of AI literacy and incorporation into curricula. Children's evaluations of their knowledge of AI as low (Mertala & Fagerlund, 2024) underscores the importance of examining children's conceptions and misconceptions of AI to develop AI literacies. Results, such as above, highlight the importance of examining the interactions and understanding of AI, which in turn requires AI literacy. In addition, methods and teaching materials actualizing AI literacy in teaching have started to emerge (e.g., Aravantinos et al., 2024; Denning & Tedre, 2021; Druga et al., 2019; 2022; Irgens et al., 2022; Lee et al., 2021; Shamir & Levin, 2022; Vartiainen et al., 2021), also regarding teaching methods and material for AI ethics in AI literacy (Payne, 2019). However, AI teaching often focuses on technical education, creativity and design thinking are not the primary goals (Rong et al., 2024). In addition, harnessing technology in CCI to engage with sustainability issues has mostly focused on games or physical computing or games by considering ES as an application area, thus, how different technologies can advance constructionist ES learning requires further research (Vasalou & Gauthier, 2023).

In this study, we examine how text-to-image generation can serve as an educational tool to help children conceptualize and create solutions to sustainability challenges. By utilizing generative AI, we encourage creative thinking and collaborative knowledge-building around sustainability concepts, particularly within phenomenon-based and project-based learning, as pedagogical approaches. This educational setting integrates STEAM, multiliteracy, AI literacy, futures literacy (FL), and transversal competencies, including ICT competencies, and supports students in participating and contributing to a sustainable future. We also explore the potential of generative AI to align with multiple UN Sustainable Development Goals by engaging children to visualize and co-create solutions that reflect these goals.

Our data collection took place within the *World at Play* interactive exhibition, a hands-on learning environment designed to engage children with sustainability through creative and digital exploration. The findings from this exhibit highlight both the benefits and challenges of using generative AI to enhance children's understanding of sustainability. To guide the students, we provided a list of 14 sustainability topic examples—each linked to various SDGs across the three sustainability pillars—to inspire solution ideas. We analyzed the prompts created by children using text-to-image generative AI to assess how well this technology fosters creativity, critical thinking, and environmental awareness. Co-occurrence network

analysis was utilized to explore children's conceptualizations and how effectively generative AI represented their envisioned sustainability solutions. This research offers valuable insights into how AI-generated visual representations influence children's perceptions of sustainability, while also informing the design of AI tools that can support ethical and imaginative representations of complex sustainability challenges.

2. The Potential Roles of Generative AI in the Education for Sustainable Development

As educational systems globally confront the pressing need to prepare students for a sustainable future, integrating digital technologies, particularly generative AI, into sustainability education has garnered significant interest. Vasalou and Gauthier's (2023) examination of CCI with ES underscores the capacity of interactive technologies to deepen children's engagement with environmental issues. They emphasize how digital tools, though underutilized for sustainability, can enhance critical thinking by helping students visualize ecological impacts and form connections to natural environments. This approach aligns with the Finnish National Core Curriculum, which highlights transversal competencies such as cultural competence, multiliteracy, and ICT skills, foundational for students facing today's complex societal challenges, including sustainability (FNBE, 2016).

On an international scale, global frameworks such as UNESCO's Education for Sustainable Development (ESD) and the European Commission's GreenComp emphasize that sustainability education must transcend theoretical learning to foster skills that empower students as proactive global citizens (UNESCO, 2017; EC, 2022). Generative AI tools might contribute to dynamic platforms where students can visualize and experience certain aspects of environmental challenges, explore alternative scenarios, and develop their FL—the ability to imagine sustainable solutions for current and future issues.

Recent studies highlight how AI-driven personalization in learning can significantly impact sustainability education. According to UNESCO (2023), generative AI enables students to address sustainability topics through personalized, context-rich engagements, enhancing both relevance and retention of learning. Alamäki et al. (2024) echo this, showing that AI literacy not only equips students to approach sustainability issues with interdisciplinary knowledge but also encourages active problem-solving. Nevertheless, challenges remain; infrastructural and further technological limitations and a lack of teacher preparedness, underscored in UNESCO's ESD roadmap (2020) and Celik's (2023) framework for AI literacy, restrict the potential impact of AI integration, especially in under-resourced educational settings. The ethical considerations highlighted by Abulibdeh et al. (2024) further underscore the need for careful, ethically grounded AI use in education, advocating for training frameworks like Celik's Intelligent-TPACK model, which supports teachers in implementing AI in an ethically responsible manner (Celik, 2023). Furthermore, research stresses the role of participatory learning in sustainability education. The UNECE strategy, as detailed by Hadjiachilleos and Zachariou (2022), calls for a comprehensive, whole-school approach to ESD that emphasizes student involvement and shared values. This aligns with Torsdottir et al. (2024), who argue that student agency is essential for nurturing environmental responsibility. Mandapuram et al.