The Social Science Review A Multidisciplinary Journal. Special Issue, Summer 2025. 73-76
Published by: Pather Dabi Educational Trust, (Regn No: IV-1402-00064/2023), Under Govt. of West Bengal, India

The Social Science Review
A Multidisciplinary Journal
ISSN: 2584-0789
(Open-Access, Peer-Reviewed, Refereed, Bi-Monthly, International e-Journal)
Homepage: www.tssreview.in

USING CHATGPT TO ADDRESS MISCONCEPTIONS ABOUT SUSTAINABILITY AMONG PRE-SERVICE TEACHERS: A QUALITATIVE CASE STUDY

Dr. Uzma Siddiqui

RESEARCH ARTICLE

Author Details:
Assistant Professor,
Department of Education,
Aligarh Muslim University,
Aligarh, Uttar Pradesh. India

Corresponding Author:
Dr. Uzma Siddiqui

DOI:
https://doi.org/10.70096/tssr.250307014

Abstract

Sustainability is a critical concept for addressing contemporary global challenges, yet misconceptions about its principles often impede meaningful engagement among pre-service teachers. This qualitative case study explores how they can overcome misconceptions about sustainability and develop a more comprehensive understanding using ChatGPT, an Artificial Intelligence (AI)-powered conversational tool. Over the course of six days, participants engaged with ChatGPT to clarify sustainability concepts, challenge preconceived notions, and reflect on their role in promoting sustainable practices in their personal and professional lives. Data were collected through semi-structured interviews, reflective journals, and focus group discussions. The findings reveal that ChatGPT facilitated personalized, real-time learning, enabling pre-service teachers to confront and resolve their misconceptions. Interactive features such as scenario-based discussions, access to global case studies, and exploratory dialogues helped deepen their understanding of sustainability as a multidimensional concept encompassing environmental, social, and economic dimensions. Participants expressed increased confidence in identifying practical sustainability strategies and applying them in contextually relevant ways. The study highlights the transformative potential of integrating AI tools into sustainability education, emphasizing the importance of guided usage to address challenges such as over-reliance on AI-generated information. Recommendations are provided for incorporating AI-driven platforms into higher education to enhance sustainability awareness and foster critical thinking. This research contributes to understanding how technology can empower pre-service teachers to become advocates for sustainable development in diverse fields.

Keywords: *Artificial Intelligence, ChatGPT, Misconceptions, Sustainability, Pre-Service Teachers*

Introduction

Sustainability is a multifaceted concept that often suffers from misconceptions, particularly regarding its implementation and impact. One common misconception is that sustainability solely focuses on environmental aspects, neglecting the economic and social dimensions that are equally crucial for achieving comprehensive sustainable development (Goralski & Tan, 2020; Vaio, Hassan, & Escobar, 2020). Additionally, there is a belief that sustainability efforts are inherently costly and economically unfeasible, which can deter businesses and governments from pursuing sustainable practices (Uwaoma, Eleogu, Okonkwo, Farayola, Kaggwa, & Akinoso, 2024; Vaio, Palladino, Hassan, & Escobar, 2020). These misconceptions can hinder the adoption of sustainable practices and policies, making it essential to address them through innovative solutions.

Artificial Intelligence (AI) has emerged as a powerful tool to overcome these misconceptions and drive sustainability across various sectors. AI can optimize resource management, enhance energy efficiency, and support sustainable business models by providing data-driven insights and solutions (D'Amore, Di Vaio, Balsalobre-Lorente, & Boccia, 2022; Nishant, Kennedy, & Corbett, 2020; Uwaoma, Eleogu, Okonkwo, Farayola, Kaggwa, & Akinoso, 2024). By integrating AI into sustainability efforts, organizations can achieve significant improvements in environmental management and resource utilization, thereby dispelling the myth that sustainability is economically burdensome (Adewale, Ene, Ogunbayo, & Aigbavboa, 2024; Uwaoma, Eleogu, Okonkwo, Farayola, Kaggwa, & Akinoso, 2024).

Literature Review

AI and Sustainability

AI's potential to transform sustainability practices is well-documented in the literature. AI technologies are being leveraged to address complex environmental challenges, such as optimizing energy consumption, improving waste management, and

enhancing the efficiency of supply chains (Adewale, Ene, Ogunbayo, & Aigbavboa, 2024; Nishant, Kennedy, & Corbett, 2020; Uwaoma, Eleogu, Okonkwo, Farayola, Kaggwa, & Akinoso, 2024). For instance, AI-driven models can significantly reduce the carbon footprint of AI systems themselves, a field known as Green AI, which focuses on minimizing the environmental impact of AI technologies. Moreover, AI's ability to process large datasets allows for better decision-making and strategic planning in sustainability initiatives (Adewale, Ene, Ogunbayo, & Aigbavboa, 2024; Uwaoma, Eleogu, Okonkwo, Farayola, Kaggwa, & Akinoso, 2024).

Overcoming Misconceptions

AI plays a crucial role in overcoming misconceptions about sustainability by demonstrating the economic viability and comprehensive benefits of sustainable practices. AI can facilitate the achievement of the United Nations Sustainable Development Goals (SDGs) by optimizing production and consumption patterns, thus proving that sustainability can be both economically and environmentally beneficial (Goralski & Tan, 2020; Kulkov, Kulkova, Rohrbeck, Menvielle, Kaartemo, & Makkonen, 2023; Vaio, Palladino, Hassan, & Escobar, 2020). Furthermore, AI's integration into business models can drive cultural shifts towards sustainability, challenging the notion that sustainable practices are incompatible with business growth (Kulkov, Kulkova, Rohrbeck, Menvielle, Kaartemo, & Makkonen, 2023; Vaio, Palladino, Hassan, & Escobar, 2020).

Challenges and Opportunities

Despite its potential, the application of AI in sustainability faces several challenges, including data integration issues, cybersecurity risks, and the need for regulatory oversight to ensure ethical use (Fan, Yan, & Wen, 2023; Nishant, Kennedy, & Corbett, 2020). Addressing these challenges requires a multi-stakeholder approach and robust governance frameworks to maximize AI's positive impact on sustainability (D'Amore, Di Vaio, Balsalobre-Lorente, & Boccia, 2022; Fan, Yan, & Wen, 2023). Future research should focus on enhancing the transparency and scalability of AI models, as well as exploring their integration with emerging technologies to further advance sustainability goals (Fan, Yan, & Wen, 2023; Kulkov, Kulkova, Rohrbeck, Menvielle, Kaartemo, & Makkonen, 2023).

In summary, AI offers significant opportunities to address misconceptions about sustainability by providing innovative solutions that demonstrate the economic and environmental benefits of sustainable practices. By overcoming implementation barriers and fostering responsible use, AI can play a pivotal role in achieving a sustainable future.

Research Objectives

1. To identify common misconceptions about sustainability among pre-service teachers
2. To analyze how ChatGPT can facilitate deeper understanding and critical thinking about sustainability concepts
3. To assess the effectiveness of AI-driven learning in addressing misconceptions and fostering engagement with sustainability.

Methodology

This study employed a qualitative case study approach.

Participants

The researcher conducted this study on a group of 16 pre-service teachers enrolled in B.A.-B.Ed. programme at the Department of Education, Aligarh Muslim University, Aligarh, Uttar Pradesh, with languages and social sciences as their major subjects respectively. These participants were purposively selected on the basis of their academic interest in sustainability and willingness to engage with ChatGPT. Moreover, they had sustainability as one of the core courses in their B.A.-B.Ed. programme.

Data Collection

The researcher employed the following tools for data collection

Semi-Structured Interviews: Researcher conducted such interviews before and after the intervention to explore initial misconceptions and assess changes in understanding.

Reflective Journals: Participants maintained weekly journals documenting their interactions with ChatGPT, and key thoughts and insights.

Focus Group Discussions: At the end of the study, researcher carried out these discussions with participants to gather collective feedback on the effectiveness of ChatGPT in overcoming their misconceptions.

Intervention: Participants engaged and interacted actively with ChatGPT on sustainability topics, including its dimensions (environmental, social, and economic), practical applications, and challenges. Researcher guided them on using ChatGPT for scenario-based discussions, case study analysis, and problem-solving exercises. This intervention lasted for six days, one hour per day.

Data Analysis

Researcher used thematic analysis to identify patterns and themes in the collected data. Transcripts from interviews and focus groups, along with reflective journals, were coded and analyzed to capture changes in understanding.

The following table summarizes the themes, initial codes, and sample responses from the study

Table 1: The themes, initial codes, and sample responses of the study

Theme	Initial Codes	Sample Responses from Participants
Misconceptions about Sustainability	• Sustainability is only about the environment. • It mostly involves government policies. • Social sustainability is just about equality.	• "I always thought sustainability was just about reducing plastic waste, but now I see it includes economics and social aspects too." • "I assumed sustainability was only relevant for environmentalists, but now I realize it's something that affects all professions."
AI as a Tool for Conceptual Clarity	• ChatGPT provided quick, clear definitions. • AI can simplify complex ideas. • Asking follow-up questions helped me refine my understanding.	• "ChatGPT explained sustainability using real-world examples, which helped me understand it better." • "I liked how I could ask the same question in different ways and get new insights each time – It made learning more engaging."
Shifts in Perception and Critical Thinking	• I now see sustainability as a long-term strategy. • Sustainability applies to businesses too. • I feel more confident discussing sustainability.	• "I used to think sustainability was just about saving trees, but now I realize it's about long-term planning in every sector." • "I feel more confident in discussing sustainability. Before, I would avoid the topic because I wasn't sure about certain concepts."
Challenges and Limitations of AI-Based Learning	• ChatGPT sometimes gives generic responses. • I had to ask multiple times for deeper explanations. • There's a risk of over-reliance on AI.	• "Sometimes, ChatGPT gave me generic answers, and I had to ask multiple times to get a deeper explanation." • "I was worried that I might be relying too much on AI instead of researching on my own."

Findings

1. **Prevalence of Misconceptions about Sustainability**
   Many pre-service teachers initially held a narrow view of sustainability, primarily associating it with environmental conservation. Several participants believed sustainability was limited to actions such as reducing plastic waste and conserving natural resources, while overlooking its economic and social dimensions. Additionally, some participants assumed sustainability was only relevant for policymakers and environmental activists, rather than a concept applicable to various professional fields.
2. **Role of ChatGPT in Conceptual Clarity**
   Participants reported that ChatGPT helped them challenge and refine their understanding of sustainability by providing real-world examples, case studies, and interactive discussions. The ability to ask follow-up questions allowed them to clarify doubts, while scenario-based explanations facilitated deeper engagement with complex sustainability issues. Many participants noted that AI-generated content made sustainability more relatable and encouraged them to think beyond textbook definitions.
3. **Development of Critical Thinking and Awareness**
   Over the course of the intervention, participants demonstrated an increased ability to analyze sustainability-related issues from multiple perspectives. They expressed greater confidence in discussing sustainability concepts and applying them to real-world scenarios. Reflection exercises revealed that they became more aware of the interconnected nature of environmental, social, and economic sustainability, leading to a more holistic understanding of the subject.
4. **Challenges and Limitations of AI-Based Learning**
   While ChatGPT enhanced conceptual clarity, some participants identified limitations. A few participants found AI-generated responses to be overly general or lacking depth in certain areas, requiring them to refine their queries for more precise answers. Additionally, concerns were raised about the potential for over-reliance on AI, with some participants emphasizing the need for supplementary academic sources to validate information.

Discussion

The findings underscore the role of AI-powered tools in enhancing sustainability education by addressing misconceptions and fostering deeper engagement with complex concepts. The ability of ChatGPT to provide real-time explanations and facilitate exploratory learning aligns with constructivist learning theories, which emphasize active knowledge construction through interaction and reflection. The study also highlights the importance of personalized learning experiences. Unlike traditional classroom settings, where students may hesitate to ask questions, AI-enabled platforms allow for self-paced inquiry, encouraging learners to explore sustainability concepts in greater depth. The integration of scenario-based learning further reinforces conceptual understanding by enabling students to examine sustainability challenges within diverse contexts.

Despite these benefits, the study also raises concerns about the limitations of AI-based learning. While ChatGPT offers a vast repository of information, it lacks the ability to critically evaluate sources, potentially leading to the dissemination of oversimplified or biased content. Additionally, students' tendency to rely heavily on AI-generated responses suggests the need for guidance in developing critical digital literacy skills.

Recommendations

1. Integration of AI in Sustainability Education – Higher education institutions should incorporate AI-driven tools like ChatGPT as supplementary resources to enhance students' understanding of sustainability concepts.
2. Developing Critical Digital Literacy – Students should receive training on how to critically assess AI-generated content, ensuring they verify information using credible academic sources.
3. Facilitating Guided AI Usage – Instructors should design structured interventions that combine AI-based learning with discussions, case studies, and collaborative activities to prevent over-reliance on AI tools.
4. Encouraging Reflexive Learning – Assignments should include reflective components where students critically analyze the insights gained from AI interactions and apply them to real-world sustainability challenges.
5. Enhancing AI Responsiveness – Developers of AI learning tools should focus on improving contextual depth in sustainability-related discussions, ensuring that responses align with current research and global best practices.

Conclusion

This study demonstrates the potential of AI-powered tools like ChatGPT in addressing misconceptions and enhancing pre-service teachers' understanding of sustainability. By providing instant feedback, personalized explanations, and interactive discussions, AI fosters deeper engagement with sustainability concepts. However, the findings also emphasize the need for guided AI usage to mitigate challenges such as over-reliance on AI-generated content and the need for critical evaluation of information. As the role of AI in education continues to expand, it is crucial to integrate digital literacy training and structured interventions to ensure meaningful learning experiences. Future research should explore long-term impacts of AI-driven sustainability education and examine how different AI models can be optimized for fostering interdisciplinary sustainability knowledge.

Acknowledgment: No
Author's Contribution: *Dr. Uzma Siddiqui:* Data Collection, Literature Review, Methodology, Analysis, Drafting, Referencing
Declaration: Not Applicable
Competing Interest: No

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