

## **Learning beyond Classrooms: Perspectives on Sustainability in Higher Education**

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### **Abstract**

Sustainability has become an important focus in higher education as institutions try to reduce environmental impact while maintaining quality learning. This study examines students' perceptions of the environmental footprint of digital, traditional, and hybrid learning models. Primary data were collected through a structured questionnaire. Percentage analysis and visualization were conducted using Power BI, and a Chi-square test in R was used to examine the relationship between environmental perceptions and support for hybrid learning.

The findings show that most respondents believe digital learning has a lower environmental impact, mainly due to reduced transportation and resource usage. At the same time, hybrid learning is widely accepted as a balanced and sustainable approach. The study highlights the importance of combining digital efficiency with physical interaction to support both sustainability and effective learning in higher education.

## **I. INTRODUCTION**

In recent years, sustainability has become a key concern in education due to climate change, resource scarcity, and environmental awareness. Educational institutions are now expected to adopt environmentally responsible practices.

Traditional classroom learning is often linked with higher environmental impact because of transportation, electricity usage, infrastructure maintenance, and paper consumption. These factors increase carbon emissions and resource use.

Digital learning, on the other hand, reduces physical travel and material consumption. However, it also raises concerns related to energy consumption, digital infrastructure, and screen dependency.

Hybrid learning has emerged as a promising solution, combining the flexibility of digital learning with the benefits of physical interaction. This model may offer a sustainable balance while ensuring student engagement and effectiveness.

Therefore, this study explores students' perceptions of different learning models and evaluates whether hybrid learning can support sustainability in higher education.

### **Objectives**

- To examine students' perceptions of the environmental footprint of digital, traditional, and hybrid learning models.
- To identify which learning mode is considered the most environmentally sustainable.
- To analyse major environmental impact factors in traditional classroom learning.
- To study the relationship between environmental perceptions and attitudes toward hybrid learning.
- To provide insights that help institutions adopt sustainable and effective learning strategies.

### **Scope of the Study**

This study focuses on sustainability perceptions in higher education learning models. It mainly examines environmental aspects such as transportation, electricity usage, infrastructure, and paper consumption. The study considers student opinions as a basis for evaluating sustainability. It does not measure actual environmental impact but provides perception-based insights.

The results can support educational institutions in planning sustainable learning strategies and policy decisions.

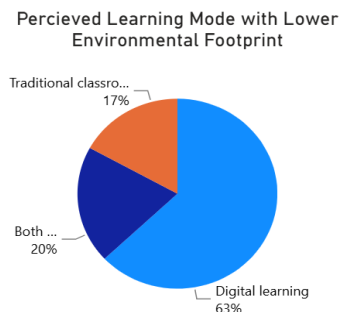
## Research Methodology

- **Research Design:** This study follows a descriptive and analytical research design.
- **Data Source:** Primary data were collected through an online structured questionnaire.
- **Sampling Method:** Convenience sampling.
- **Sample Size:** 100 respondents from higher education.
- **Tools Used:**
  - MS Excel for data cleaning
  - Power BI for visualization
  - R software for Chi-square test
- **Techniques:**
  - Percentage analysis
  - Data visualization
  - Chi-square test

## Analysis and Interpretation

### Percentage Analysis: Perceived Environmental Footprint

11. Which learning mode do you think has a lower environmental footprint overall?

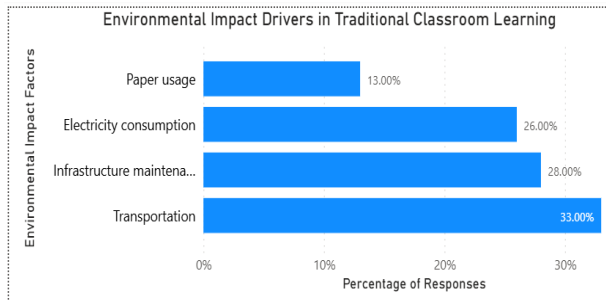


The percentage analysis shows that a majority of respondents perceive digital learning as having the lowest environmental footprint. Specifically, 63% of respondents identified digital learning as the most environmentally sustainable mode. In contrast, 17% of respondents believed that traditional classroom learning has a lower environmental impact. Additionally, 20% of respondents considered both learning models to be equally sustainable.

This result indicates a strong preference for digital learning due to its perceived ability to reduce transportation, paper usage, and physical infrastructure dependence. It also reflects growing environmental awareness among students in higher education.

**Bar Chart Analysis: Environmental Impact Factors in Traditional Learning**

12. In your opinion, which factor contributes most to environmental impact in traditional education?

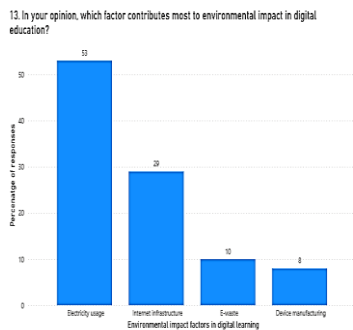


The bar chart analysis highlights the major environmental factors associated with traditional classroom learning. Among the respondents:

- 33% identified transportation as the most significant environmental impact factor.
- 28% pointed to infrastructure maintenance, including building facilities and campus operations.
- 26% indicated electricity consumption as a major concern.
- Only 13% of respondents considered paper usage as the primary environmental factor.

These findings suggest that mobility and physical campus requirements are the key drivers of environmental impact in traditional learning environments. It also indicates that reducing travel and improving infrastructure efficiency can significantly enhance sustainability.

**Bar Chart Analysis: Environmental Impact Factors in Digital Learning**



The analysis of environmental impact factors in digital education highlights that digital learning, although perceived as sustainable, also has significant environmental challenges. The results show that 53% of respondents identified

electricity usage as the most important factor contributing to environmental impact in digital learning. This was followed by 29% of respondents who pointed to internet infrastructure as a major concern. Additionally, 10% of respondents indicated e-waste, while 8% considered device manufacturing as the primary environmental factor.

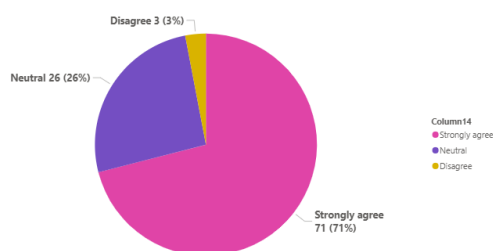
These findings suggest that digital learning is not completely free from environmental impact. The high level of concern regarding electricity usage reflects the growing awareness about energy consumption associated with online platforms, data centres, and continuous device usage. Similarly, concerns related to internet infrastructure highlight the environmental costs involved in maintaining digital networks and cloud services.

The relatively lower concern for e-waste and device manufacturing may indicate limited awareness among students about the long-term environmental consequences of electronic waste. However, these factors remain important from a sustainability perspective.

Overall, this analysis demonstrates that while digital learning reduces transportation and physical resource usage, it also introduces new environmental challenges. Therefore, complete digitalisation may not be a fully sustainable or practical solution

### **Perception of Hybrid Learning for Sustainable Higher Education**

14. Do you believe hybrid learning can support sustainable higher education?



The analysis of respondents' opinions on whether hybrid learning can support sustainable higher education reveals strong support for blended learning models. The results show that 71% of respondents strongly agreed that hybrid learning can contribute to sustainability in higher education. In comparison, 26% of respondents expressed a neutral opinion, while only 3% disagreed with the statement.

This finding clearly indicates a high level of confidence among students regarding the role of hybrid learning in promoting sustainability. The strong agreement reflects the belief that hybrid models can reduce environmental impact

by minimizing travel and resource consumption while still maintaining necessary face-to-face interaction. The presence of neutral responses suggests that some students may require more awareness or practical exposure to hybrid learning environments.

Overall, the results highlight that hybrid learning is not only perceived as environmentally sustainable but also widely accepted as a practical and future-oriented educational approach. This supports the idea that higher education institutions can adopt hybrid learning strategies to achieve both sustainability and academic effectiveness.

### **Chi-Square Test: Relationship between Environmental Perception and Hybrid Learning**

A Chi-square test was conducted to examine whether students' perceptions of environmental footprint influence their support for hybrid learning sustainability.

The results showed no statistically significant relationship between these variables ( $\chi^2 = 4.23$ ,  $df = 4$ ,  $p = 0.38$ ). Since the p-value is greater than 0.05, the null hypothesis was accepted.

This indicates that students' support for hybrid learning is not dependent on their specific environmental perception. Instead, hybrid learning appears to be accepted for multiple reasons such as flexibility, convenience, and effectiveness.

### **Findings and Discussion**

The findings of this study provide important insights into how students view sustainability in higher education. The strong perception that digital learning has a lower environmental footprint aligns with global trends that focus on reducing carbon emissions and physical resource consumption. The high percentage of respondents (63%) supporting digital learning indicates that students are increasingly aware of environmental issues and expect educational institutions to adopt sustainable practices.

At the same time, the results highlight that transportation is the most critical factor influencing environmental impact in traditional classroom learning. This is consistent with earlier studies showing that daily commuting and campus-related travel contribute significantly to carbon emissions. Therefore, reducing unnecessary travel through flexible and blended learning models can play an important role in promoting sustainability in higher education.

However, the analysis of environmental factors in digital learning also reveals that digital education is not completely free from environmental concerns. A majority of respondents identified electricity usage and internet infrastructure as key contributors to environmental impact in digital learning. This suggests that increased

dependence on digital platforms, data centres, and continuous device usage can lead to higher energy consumption. Although fewer respondents identified e-waste and device manufacturing as major concerns, these factors remain important in the long term. These findings highlight that complete digitalisation may not be a fully sustainable or practical solution.

The Chi-square analysis further showed that support for hybrid learning remains consistent across different perception groups. This indicates that students favour hybrid learning not only because of its environmental advantages but also due to its flexibility, convenience, and ability to improve learning outcomes. In addition, the strong agreement among respondents that hybrid learning can support sustainable higher education reflects growing acceptance of blended learning models.

These results suggest that sustainability in education should not be viewed as a choice between digital and traditional learning. Instead, institutions should aim to create balanced and adaptive systems that integrate digital innovation with responsible physical infrastructure. Hybrid learning offers this balance by reducing transportation and resource usage while maintaining necessary face-to-face interaction and engagement.

Overall, this study contributes to the ongoing discussion on sustainable higher education by highlighting the importance of hybrid learning as a practical, flexible, and future-ready model. Educational institutions, policymakers, and stakeholders can use these insights to design learning strategies that promote environmental sustainability without compromising academic quality and student experience.

## **Suggestions**

Based on the findings of this study, the following suggestions are proposed to support sustainable higher education:

### **1. Promote hybrid learning models in higher education**

Educational institutions should adopt hybrid learning approaches that combine digital and physical learning. This model can reduce transportation-related emissions while maintaining student engagement and interaction.

### **2. Reduce environmental impact of traditional learning:**

Universities should introduce flexible schedules, online components, and remote learning options to minimise daily travel. Institutions can also promote carpooling, public transport, and eco-friendly campus initiatives.

### **3. Improve energy efficiency in digital learning systems**

Since electricity usage and digital infrastructure were identified as major environmental concerns, institutions should invest in energy-efficient technologies, renewable energy sources, and green data centres.

### **4. Increase awareness about digital sustainability**

Students should be educated about responsible digital practices, including reducing screen time, proper device usage, and electronic waste management.

### **5. Develop sustainable infrastructure policies**

Higher education institutions should focus on green campuses, efficient infrastructure, and digital resource optimisation to create long-term sustainable learning environments.

## **II. CONCLUSION**

This study highlights that students increasingly perceive digital learning as environmentally sustainable due to reduced transportation and physical resource consumption. However, the findings also reveal that digital learning is not entirely free from environmental impact, particularly in terms of electricity usage and digital infrastructure.

Traditional classroom learning continues to be associated with higher environmental impact, mainly due to travel and infrastructure-related factors. At the same time, strong support for hybrid learning suggests that students prefer a balanced approach that combines the advantages of both digital and physical learning.

The study therefore concludes that hybrid learning offers a practical and sustainable solution for higher education. By integrating digital efficiency with meaningful classroom interaction, hybrid models can help institutions achieve environmental sustainability while maintaining academic quality.

Overall, this research contributes to the growing understanding of sustainable education and provides useful insights for policymakers, educators, and institutions in designing future-ready and environmentally responsible learning systems.

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