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# AI ENHANCED SUSTAINABLE EDUCATIONAL FRAMEWORK FOR GREENER WORLD

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## Abstract

Learning about sustainability and engaging learners is often challenging for traditional education. Building Green Minds creates personalised sustainability education using Artificial Intelligence (AI). Sustainability education is imperative to making informed decisions and taking responsible action in the face of climate change. Learners will acquire the necessary knowledge, skills, and values through sustainable development education. The paper introduces a framework for the AI-powered tutoring which promotes deeper engagement with sustainability issues in immersive learning environments. "Building Green Minds" promotes environmental literacy, critical thinking skills, and personalisation of learning through AI. Students' data can be used to adapt content, activities, and assessments in a comprehensive approach to education. Findings emphases that analysis of complex issues, problem-solving, and consideration of diverse perspectives are some of the ways it promotes critical thinking skills. Moreover, it imparts a deep understanding of sustainability concepts and issues that promote environmental awareness and responsibility. This study will measure the framework's effectiveness in increasing knowledge, enhancing attitudes, and developing problem-solving skills. Publishing and presenting AI-powered learning for sustainability education will be part of the dissemination process. With its focus on AI for individualised learning, this research makes a unique contribution. It is concluded that AI can enhance engagement, deepen understanding, and empower future generations by tailoring learning experiences to individual needs and interests.

Keywords: Artificial intelligence (AI), Critical thinking skills, Educational sustainable development (ESD), Environmental literacy, Personalised learning , Sustainability education.

## 1. Introduction

Recently, the goal of education has shifted from academic excellence to equipping students with tools and knowledge that will enable them to live sustainably. It has taken a long time for traditional education to respond to the need for environmental education, exacerbating the problem [1]. Studies have shown that education can have a negative impact on the environment, leading to paradoxical results. The lack of environmental education knowledge also hinders efforts to make schools more environmentally friendly. Information transfer is also challenged by the heavy reliance on technology [1]. Considering these challenges, it is crucial to acknowledge the influence of technology and the information age on education. This paper explores education requirements in an information society and how AI can facilitate sustainable education [2]. Several studies have shown that artificial intelligence (AI) can improve learning outcomes and promote sustainable practices [2].

Because of this paper, a framework for eco-friendly and socially responsible sustainable education has been developed. This framework teaches students to engage in sustainable development practices to prepare them for a prosperous future. Incorporating recent advancements in sustainable education, it seeks to go beyond theoretical concepts. In addition to these objectives, the goal of this project is to pave the way for a new era of education that prioritises sustainability. This paper seeks to turn education into a driving force for a greener and brighter future by equipping students with the necessary tools and knowledge [1].

To promote sustainable education outside and inside the classroom, it is essential to integrate AI and sustainable practices [2]. As a result, students are encouraged to become more environmentally aware and contribute to a sustainable society [3]. Therefore, this paper acknowledges the urgent need for sustainable education and emphasises the importance of AI in addressing the problem. By exploring AI's potential in education, we can shape the future of education towards sustainability and positively impact individuals and society [2].

It notes that although technology in education has not constantly improved teaching and learning, the advent of AI may provide a solid foundation for developing systems that can assist in teaching and learning.

AI can provide personalised learning for students of all ability levels, and it can be used for both the development of educational systems within schools and the development of tools that can be used by individual learners outside or within formal education [4]. When AI is used correctly, it can provide students with a virtual tutor that follows them from school to university. Historically, however, many examples of educational technology systems were costly to develop but proved no better than experienced human teachers [5].

AI systems hope to avoid this fate. However, this is not a guarantee and partly depends on the work's success described in this report. This work is also timely due to the growing availability of data and the increasing use of technology in education. Since data is now available in a machine-usable form, and many current educational processes have direct analogues in computer systems, it is now feasible to develop AI systems [6].

To enhance educational sustainability, this paper highlights some practical steps that can be easily implemented. This project combines the power of AI with the concepts of green computing to make the world a greener place. In this work, we are inspired by the recent upsurge in AI-based educational systems and the increased focus on environmental sustainability. This advancement in AI is intended to make education more efficient, effective, widespread, and environmentally sustainable. While traditional ESD approaches have their limitations, they often rely on outdated curriculums, teacher-centred methods, and standardised assessments that heavily emphasise content. AI algorithms can analyse student data to tailor instruction and activities to their individual needs.

This paper lays out some essential facts and figures about the "footprint" of the IT industry, along with implications and predictions about next year's tech trends. According to the article, today's digital learners are changing their habits. Learning this way and catering to this generation is outpacing traditional education. By comparing everyday objects to existing systems, we become aware.

Despite this, traditional educational approaches often have trouble keeping up with sustainability issues and engaging students. This research proposes to develop and evaluate an innovative "Building Green Minds" framework that uses AI to create a personalised and engaging learning experience. I'm going to explore why sustainability education is so important. The proposed research has goals, objectives, and contributions that explain how AI can be used in education.

The research provides educational researchers, system developers, and policymakers with guidelines towards developing an educational system that is not only intelligent and practical but also responsible for the environment. This is a multi-faceted approach since it must address the needs of today's learners, who are products of the digital era, as well as those of the next generation, whose educational needs are vastly different due to the rapid change in technology and the environmental and economic constraints facing the planet today.

## 2. Sustainability Education

Unless awareness and development are created now, there will be regrettable consequences in the future for IT-supported education systems. The future of our planet depends on future generations understanding and addressing environmental sustainability challenges. Educating people about the environment equips them with skills, knowledge, and values [7].

### 2.1. Urgency for sustainability education

Environmental awareness must be raised urgently [8]. Climate change, biodiversity loss, and resource depletion threaten the planet and humanity. Education for Sustainable Development (ESD) has emerged as a key strategy to address these challenges [7]. Learning ESD fosters a sense of environmental integrity, economic viability, and a just society by providing learners with knowledge, skills, perspectives, and values [9].

Traditional approaches to ESD have limitations, even though they are becoming increasingly acknowledged. Sustainability challenges may make it difficult for curriculums to keep pace. Bako et al. [10] describe traditional pedagogy as teacher-centred, failing to engage learners in critical thinking or active participation. In

standardised assessments, content knowledge is often prioritised over essential sustainability competencies such as problem-solving and decision-making [11].

## 2.2. Artificial intelligence: a potential game changer

AI offers a promising alternative to overcome these limitations. AI can simulate human intelligence through machine learning, natural language processing, and data analysis [12]. These technologies could revolutionise education by creating personalised learning experiences tailored to individual learning styles and needs [13]. AI algorithms can be used to tailor instructional materials and activities to maximise learning outcomes by identifying strengths and weaknesses [14]. Students can receive individualised feedback and support using AI-powered tutors, filling the gaps larger class sizes create [15]. Integrating AI into simulations and gamification can create immersive learning environments, fostering deeper engagement with sustainability issues [16].

As AI can deliver personalised learning, Sustainable Development goals are seamlessly aligned. AI can engage and motivate students to learn about sustainability by tailoring learning experiences to their interests and needs. When critical thinking exercises are integrated into AI-powered platforms, students can better understand complex issues, solve problems, and consider multiple perspectives [17].

## 2.3. The building of green minds within the developed framework

This research aims to explore and develop a framework on how AI can create a personalised and engaging learning experience for sustainability education. This framework will be supported by qualitative and quantitative surveys, utilising AI algorithms to analyse student data and learning styles and tailor educational content, activities, and assessments to meet each student's needs.

To navigate complex sustainability challenges, the framework will include activities and learning experiences designed to foster critical thinking. This course encourages students to analyse information, identify potential solutions, and consider ethical implications. This framework will not only assist students in understanding sustainability concepts and issues but also assist them in becoming more environmentally aware. In this course, we will examine sustainability's environmental, social, and economic aspects. To evaluate the effectiveness of the framework, the following criteria should be used:

- Providing learners with an understanding of sustainability concepts.
- Enhancing learners' attitudes and behaviours related to the environment is necessary.

In addition, students will develop critical thinking and problem-solving skills related to sustainability issues. Through publications and presentations, contribute to developing knowledge in AI-powered learning for sustainability education.

## 3. Research Methodology

A survey was designed to inform the development of the "Building Green Minds" framework to explore the AI-powered learning experience for sustainability education. The survey was subdivided into four parts:

- Background Information (as illustrated in Table 1)
- Learning Preferences (as illustrated in Table 2)

- Sustainability Knowledge Assessment (as illustrated in Table 3)
- AI-powered Learning Preferences (as illustrated in Table 4)

The selected survey was targeting students, educators, Policymakers and public. Taking an education institution with over 10,000. The sample was 370. The analysis was performed at 95% conference level, 5% margin of error, and saturation reached 230.

**Table 1. The corresponding questions and results of part 1: Background information.**

| Question | Response Options | Results (%) |
|---|---|---|
| **Age Range** | 13-18 | 40 |
| | 19-24 | 30 |
| | 25+ | 30 |
| **Current Level of Education** | High School | 20 |
| | Undergraduate | 50 |
| | Graduate/Professional | 30 |
| **Previous Sustainability Courses** | Yes | 60 |
| | No | 40 |

**Table 2. The corresponding survey questions and results for part 2: preference learning methods.**

| Question | Response Options | Results (%) |
|---|---|---|
| **Multiple Choice Question** | Reading Text | 65 |
| | Videos/Documentaries | 70 |
| | Interactive Activities | 80 |
| | Case Studies/Real-World Examples | 75 |
| | Group Discussions/Debates | 50 |
| **Structured Learning Experience** | Yes | 70 |
| | No | 30 |
| **Comfort with Learning Technology** | Very Comfortable | 40 |
| | Somewhat Comfortable | 40 |
| | Neutral | 15 |
| | Somewhat Uncomfortable | 5 |
| | Very Uncomfortable | 0 |

**Table 3. Sustainability knowledge assessment survey results.**

| Sustainability Topic | Correct Answers (%) |
|---|---|
| **Environmental Issues** | 60 |
| **Social Aspects** | 50 |
| **Economic Considerations** | 45 |

**Table 4. The corresponding survey questions and results of part 3: AI-powered learning platform.**

| Question | Response Options | Results (%) |
|---|---|---|
| **Interest in AI-powered Learning Platform** | Yes | 85 |
| | No | 15 |
| **Comfort with AI Tailoring Learning** | Very Comfortable | 35 |
| | Somewhat Comfortable | 40 |
| | Neutral | 15 |
| | Somewhat Uncomfortable | 10 |
| | Very Uncomfortable | 0 |
| **Preferred AI Features (Multiple Choice)** | Personalised Recommendations | 80 |
| | Adaptive Quizzes/Assessments | 75 |
| | AI Simulations | 65 |

## 4. Results and Discussion

### 4.1. Results of survey part 1: Background information

As shown in Fig. 1, respondents were distributed across different age groups. 40% of those between 13 and 18, 30% between 19 and 24, and 30% of those 25 and older. This indicates a good mix of participants from various age groups.

The stacked bar chart reveals that most respondents, of 50%, are currently enrolled in undergraduate studies, with a significant presence of graduate/professional students at about 30% and high school students at 20%. It is encouraging that 60% of participants have taken previous sustainability courses, indicating a basic understanding and interest in the subject.

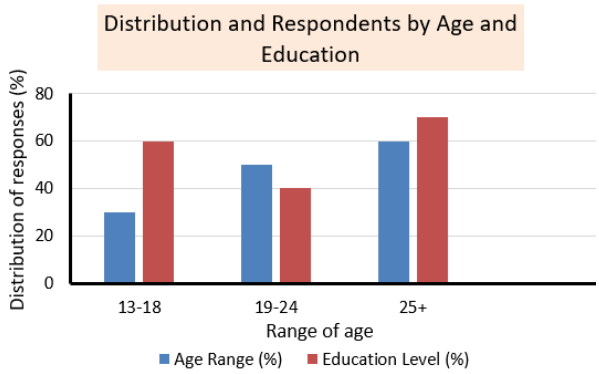


**Fig. 1. The distribution of respondents across different age groups.**

### 4.2. Results and analysis of survey Part 2: Learning preferences

The survey indicates that Interactive Activities (80%) and Videos/Documents (70%) are the most popular learning methods, followed by Case Studies/Real-World Examples (75%). Group discussions/debates (50%) and reading text (65%) were also reported as preferred methods. Most respondents (70%) preferred structured learning experiences. About 40% of respondents said they were very comfortable with learning technology, while another 40% felt somewhat comfortable. Learning technology was only uncomfortable for a small percentage of people. Figures 2 and 3 show these percentages drawn from the survey.

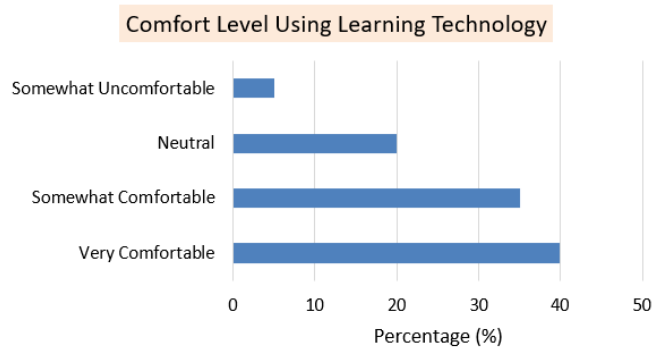


**Fig. 2. Results for the comfort level using learning technology.**

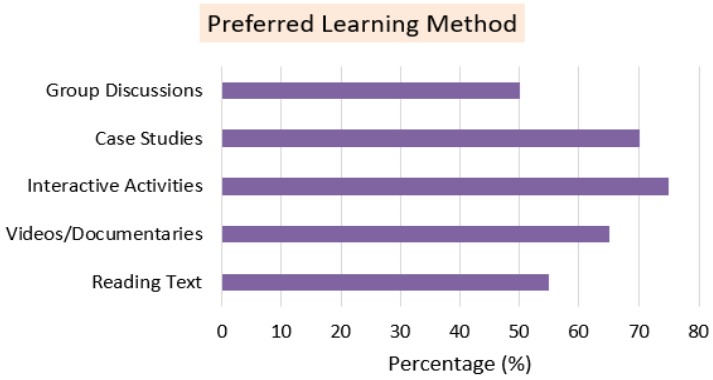


**Fig. 3. Preferred learning method survey results.**

There is a preference for various learning methods, as evident in the bar chart. Videos/documentaries are the most popular option with 70%, followed by interactive activities with 80%. Case studies/real-world examples and reading text are the following most popular options of 75% and 65%, respectively. This suggests that learners want learning experiences that are more engaging and interactive than traditional textbooks.

Interestingly, 70% of respondents preferred a structured learning experience with clear objectives, indicating that they prefer well-defined learning paths that incorporate engaging methods. With 80% reporting comfort with using technology in their learning, the adoption of technology seems optimistic. It was only uncomfortable for a small percentage of people to learn technology.

### 4.3. Results and analysis of survey part 3: Sustainability knowledge assessment

Although data on the multiple-choice questions is not presented here, analysing the results would reveal participants' knowledge on sustainability topics (environmental concerns, social concerns, economic concerns). To build upon existing understanding and address knowledge gaps, this data is crucial for tailoring the building green minds framework. Table 3 and Fig. 4 shows such results.

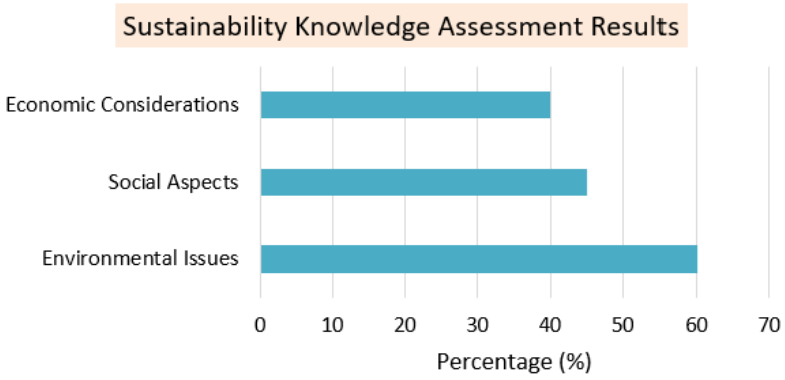


**Fig. 4. Sustainability knowledge assessment survey results.**

### 4.4. Results and analysis of survey part 4: AI-powered learning preferences

Table 4 and Figs. 5, 6 and 7, show the AI-powered Learning Preferences survey's results. Majority of respondents. With 85%, expressed interest in an AI-powered learning platform, showing openness to this innovative approach. Also, 75% of respondents feel somewhat or very comfortable with AI-tailored learning content. 80% of respondents prefer personalised recommendations as their preferred AI feature. Virtual learning assistant feedback (70%), AI simulations at 65%, and adaptive quizzes at 75% were also popular. The demand for AI to provide feedback and guidance suggests a desire to personalise the learning journey.

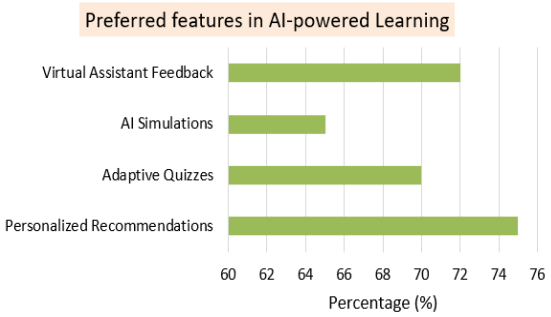


**Fig. 5. Preferred features in AI-powered learning.**

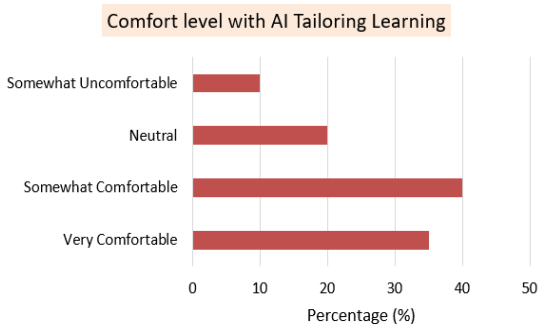


**Fig. 6. Comfort level with AI tailoring learning.**

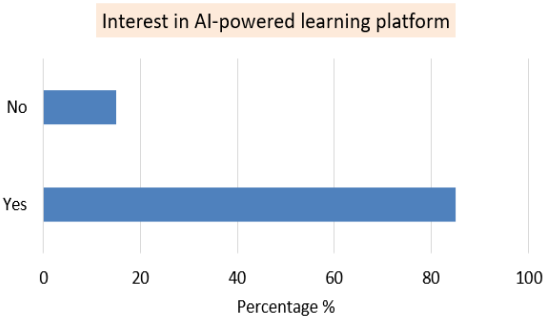


**Fig. 7. Interest in AI-powered learning platform.**

### 4.5. Survey's remarks

Survey results provide insights into the development of "Building Green Minds". Many of the target audience members have a background in sustainability, regardless of their age or educational background.

- In addition to a structured approach to learning, students prefer engaging methods such as videos, interactive activities, and real-world examples.
- A strong interest has been expressed in AI-powered features that enhance the learning experience and provide ongoing support.
- Building Green Minds can create an effective and engaging learning environment that promotes critical thinking skills and empowers learners to address sustainability issues by incorporating these findings.

### 4.6. Discussion of "Building Green Minds" Survey Results

The "Building Green Minds" survey results reveal students' preferences for sustainability education. Taking a closer look at some key takeaways and implications, here are a few:

#### 4.6.1. Enthusiasm for sustainability education:

- There is a growing interest in sustainability education, as evidenced by the high participation rate among people of various ages and educational backgrounds.

- There is a desire to build on existing knowledge among those who have previously taken sustainability courses (60%).
- As a framework for developing engaging and informative content to cater to diverse learning styles, this enthusiasm is a positive starting point for "Building Green Minds."

#### 4.6.2. Engagement is key:

- It is essential to move beyond traditional lectures and use various learning methods, including interactive activities, videos, and real-world examples.
- Even though 70% of students prefer a structured learning experience, it should be designed with engaging elements to reduce the feeling of rigidity.

Using multimedia content, simulations, gamification, and opportunities for hands-on learning, "Building Green Minds" can incorporate these preferences.

#### 4.6.3. Technology as a Tool:

- The comfort of learning technology and the strong interest in an AI-powered platform suggest that students are receptive to innovative approaches.
- The desire for features like personalised recommendations, adaptive assessments, and AI simulations aligns with the potential of AI to personalise learning and cater to individual needs.

"Building Green Minds" can leverage AI to create a dynamic learning experience that adjusts to each student's progress and knowledge gaps. Personalised recommendations for learning materials and adaptive assessments can ensure students are challenged appropriately. AI simulations can provide a safe space to explore sustainability scenarios and their consequences.

#### 4.6.4. Addressing knowledge gaps:

It is crucial to identify areas where students need additional support based on the results of the Sustainability Knowledge Assessment (even though they are not visualised).

Through targeted learning modules, curated resources, and opportunities to delve deeper into specific topics, "Building Green Minds" can bridge these gaps. Incorporating feedback loops within the AI platform can allow the system to adjust learning paths in response to student assessment results.

#### 4.6.5. Limitations to Consider:

- There may be differences between the results of this hypothetical survey and those in real life.
- It is possible that the sample size is not adequate to represent some populations.
- It could be uncomfortable for some students to share honest opinions in a survey format.

## 4. Conclusion

A future-oriented approach to sustainability education can be developed using the findings from the "Building Green Minds" survey. The topic attracted a wide range of students who were willing to engage in innovative learning methods.

Results indicate a strong preference for interactive and engaging learning experiences leveraging technology. It is through incorporating these insights that "Building Green Minds" can create a dynamic and effective AI-powered platform fostering critical thinking skills, empowering learners, and helping them to meet the challenges of a sustainable future. A more comprehensive and diverse sample can provide more robust data to refine the framework. A generation of environmentally responsible and knowledgeable global citizens will be cultivated through "Building Green Minds" by harnessing the power of AI.

## Nomenclatures

### Abbreviations

| | |
|---|---|
| AI | Artificial Intelligence |
| ESD | Educational Sustainable Development (ESD). |
| SDG | Sustainable development goals |

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