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Artificial Intelligence-Powered Technology Enhanced Learning (AIPTEL) as a Climate Change Mitigation Strategy

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Abstract

Climate crisis is an urgent transnational issue that demands global efforts from various stakeholders. The United Nations and its allied agencies, together with non-governmental organisations, are actively involved in fighting the climate crisis. Technology, particularly artificial intelligence, has long been sought as a solution to mitigate the climate crisis. This paper explores the role of Artificial Intelligence-Powered Technology-Enhanced Learning (AIPTEL) in addressing this global climate crisis. We have proposed the AIPTEL framework that serves as a mechanism to raise environmental awareness and bring about systemic changes in educational infrastructure to reduce its carbon footprint. This dual-role framework aligns with Sustainable Development Goals 4 (Quality Education) and 13 (Climate Action).

Keywords: Artificial Intelligence; Artificial Intelligence-Powered Technology-Enhanced Learning (AIPTEL); Climate Change and Education; Sustainable Development

1. Introduction

In the early centuries, food scarcity and lack of essential resources were humanity's constant woes. As civilisations advanced, human actions increasingly began harming the environment that sustained us. The developed world contributed heavily to this ecological strain in pursuit of comfort and consumption. This development did not come without cost; centuries of environmental degradation to maintain a better lifestyle and ever-increasing consumerism have emerged as humankind's most pressing existential threat. For instance, the recent Palisades Fire, which ignited on 7 January 2025 in California, burned over 23,707 acres of land, destroyed 6,837 structures (including homes, businesses, and schools), and claimed 12 lives, making it the third-most destructive wildfire in California history. A technologically advanced nation, like the USA, found it challenging to contain the wildfire in the year 2025, which was exacerbated by drought conditions and empty water reservoirs. This shows that all countries are vulnerable. If left unaddressed, climate change may cause irreversible damage to ecosystems and societies. Therefore, addressing climate change is no longer a matter of choice but an immediate necessity. Given climate change's far-reaching and transnational nature, a collective and inclusive global effort is the need of the hour.

Harnessing the power of AI in education can help mitigate the climate crisis. AIPTEL is an integrated model to increase environmental awareness and reduce educational institutions' carbon footprint by lowering transport-related, printing-related, and infrastructure-related emissions. This paper explores the potential of AIPTEL as a climate mitigation tool.

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2. Literature Review

2.1. The Global Nature of the Climate Change Crisis

The climate change crisis is universal and impacts countries irrespective of size, geography, or development status. Its manifestations are widespread. Rising sea levels, shrinking ice sheets, melting glaciers, global warming, biodiversity loss, and agricultural productivity shifts. Addressing climate change requires a multifaceted approach that leverages the strengths and resources of various stakeholders. Governments, businesses, non-profit organisations, scientists, educators, and individuals play crucial roles. There is a need for collaborative efforts because climate change is a complex issue that cannot be tackled in isolation. This problem is global. No single country or entity can address it alone. Therefore, a conscious approach at multiple levels of governance must involve coordinated action from international organisations, national governments, local authorities, and grassroots movements (Cross & Congreve, 2020). The Key Stakeholders in these collaborative efforts are:

2.1.1. Government

Government plays a crucial role by providing funds, developing infrastructure to implement AI-driven solutions, and formulating policies that promote climate-oriented initiatives, such as including climate education in school curricula and supporting AI-powered tools for teaching.

2.1.2. Educational Institutions

Educational institutions can help implement government policies and develop and implement AI-based education programs. For instance, they can create AI-powered climate simulation virtual labs with the help of tech companies.

2.1.3. Technology Companies

Technology companies can play an essential role as innovators and creators of tools and platforms dedicated to climate education.

2.1.4. NGOS and Non-Profit Organisations

NGOS can ensure that climate change education reaches the remotest educational institutions and make people understand the need for climate action in their local language.

2.1.5. Learners and Teachers

Both learners and teachers are essential in the collaborative effort to combat the climate crisis. They are not only the end-users or consumers of AI-powered education but also serve as co-creators of AI-driven educational solutions. They can help develop course material for climate education and create AI tools for climate education.

AI can accelerate progress toward the Sustainable Development Goals (SDGS), particularly climate action. Partnerships among governments, academia, and industry are key to developing AI-driven educational tools, like personalised learning systems that cater to learners from diverse backgrounds (Vinuesa et al., 2020). As technology evolves, its role in education extends beyond mere facilitation. It is transforming into a powerful catalyst for change.

2.2. AI-Powered Technology in Education: A Catalyst for Climate Action

Technology has become integral to every domain. However, in education, it plays a transformative role as an influential reformer, facilitator, and guide (George & Wooden, 2023). Technology has evolved to a stage where it is no longer viewed as a disruptor but an enabler of processes. Digital ecosystem comprising ICT tools, digital books, online learning platforms, blended learning, and mobile learning, among others, has been seamlessly integrated into teaching and learning activities. These technological advances are proving even more powerful and helpful as they become more individualistic and personalised. Incorporating Artificial Intelligence (AI) has further augmented their applicability and usefulness by enhancing the overall teaching and learning process (Baker, 2021). AI-based technologies are used to perform sophisticated data analysis. It allows teachers to orient instructional materials to meet the diverse needs of their learners. Teachers can provide timely feedback to learners (Vieriu & Petrea, 2025). With the help of AI-driven tools, administrative tasks like grading assignments and keeping a record of student attendance can be automated (Hwang et al., 2020). They can also convert speech to text and text to speech. This makes learning convenient for learners with hearing and visual impairments. AI tools promote inclusiveness by supporting differently abled learners (Habib et al., 2022). AI tools facilitate the translation of educational resources in multiple languages. This helps in making these resources accessible to non-native people.

3. Objective and Methodology

This paper aims to study the role of AI-based tools and educational practices in mitigating climate change. A comprehensive literature review brings insights on how pedagogical and infrastructural changes in educational practices help manage the climate crisis.

4. The Role of AIPTEL in Addressing the Climate Crisis

The role of AIPTEL in mitigating the climate crisis can be understood in two ways. Firstly, to leverage AIPTEL in promoting climate change education, and secondly, to leverage AIPTEL in education for climate change

4.1. Leveraging AIPTEL in Climate Change Education

AIPTEL focuses on educating people about the science behind climate change to inculcate behavioural changes by enhancing climate literacy. If there is anything that can restore the environment and mitigate the climate crisis, it is climate change education. Education alone can be critical in addressing the climate crisis (Stevenson et al., 2014). The UN Framework Convention on Climate Change (UNFCCC) has urged its agencies to raise awareness about climate change through educational and public awareness campaigns. The UN is focusing on education as an agent to mitigate the climate crisis because education can change people's attitudes, which will ultimately reflect in their behaviour. For instance, AI-powered chatbots like ChatGPT can answer complex questions about climate mitigation in real time. At the same time, VR simulations allow for the impact of rising sea levels or deforestation to be experienced. By integrating AIPTEL into their curricula, educational institutes can become torchbearers in this critical cause and guide humanity towards restoring the environment and climate (Ojala, 2012).

Climate Change Education (CCE)

CCE educates people about the causes of climate change, its consequences, and the potential solutions to tackle it (Mochizuki & Bryan, 2015). Thus, CCE is a three-step program aimed at educating people about:

- The Science of Climate Change: it is aimed at educating people about the causes of climate change (e.g., greenhouse gases), impacts of climate change (e.g., rising sea levels, global warming), and the solutions to tackle the climate change (e.g., the use of renewable energy sources such as solar power).
- Bringing About Behavioural Change: It encourages sustainable habits among children and adults (e.g., reducing waste, reuse of plastic products).
- Empowerment: Equipping learners to advocate for systemic change

UNESCO, the UN's specialised agency for education, posits CCE as a critical component of sustainable development. It supports efforts to combat climate change through awareness, engagement, and informed decision-making. One of the main goals of ESD 2030, i.e., Education for Sustainable Development by 2030, is to tackle climate change. This UNESCO program is working to make education a bigger and more prominent part of the global fight against climate change. The subsequent sections will outline how AIPTEL can be utilised to promote CCE (Anderson, 2012).

4.1.1. Personalised and Adaptive Learning

This is a student-centric educational approach in which the content is delivered based on their needs, interests, and learning style. With the integration of AI, data processing and pattern recognition have become easier, catalysing adaptive and personalised learning experiences. AIPTEL is an excellent medium for personalised learning and adapting content to individual needs, facilitating tailored information for learners based on their knowledge levels, interests, and regional climate concerns (Roll & Wylie, 2016).

4.1.2. Real-Time Feedback to Learners via Chatbots and Tutors

AI-driven chatbots and intelligent tutoring systems have revolutionised the learning pedagogy in climate science (Lin & Yu, 2023). These tools provide instant responses to learners' queries on issues concerning climate education, such as carbon cycles, renewable energy systems, or the impact of climate policy changes. They also offer a step-by-step explanation of complex concepts. Interactive diagrams may be provided to foster understanding. This provides a personalised learning experience and increases the engagement levels of students (Luckin et al., 2016).

4.1.3. Gamification and Simulations for Experiential Climate Learning

Gamification uses design elements of a game and provides gameful experiences in non-game contexts to encourage desired behavioural outcomes (Deterding et al., 2011; Hamari et al., 2014). Gamification is increasingly used in education to integrate gaming principles into the learning environment. This is a way to enhance student motivation and engagement. However, the gamification of education pedagogy is complex (Dichev & Dicheva, 2017). AI-powered gamification strategies can help transform the learning process. They provide personalised and adaptive learning experiences to enhance engagement in climate education (Babu & Moorthy, 2023). Abstract environmental models may be transformed into interactive and tangible experiences to gamify climate education. AI, with the help of games and smartphone apps, can also be used to create a simulated environment for teaching about climate change, disaster response and relief, and the impact of deforestation. This enhances sustainable behaviour at the same time. It is a way to bridge the gap between theory and real-world application of the concepts. Such AI-driven pedagogy fosters climate-conscious behaviour among learners (Velazquez-Garcia, 2024).

4.1.4. AI-Driven Augmented Reality Virtual Reality Platforms for Immersive Climate Education

Climate-related environmental changes are abstract and complex to explain in the classroom (Hwang et al., 2020). AI-powered visualisations of these concepts provide the experience of virtual ecosystems, enabling first-hand interaction with the ecosystems (Markowitz et al., 2018; Reiners et al., 2021). This helps understand complex relationships. Learners are motivated to conserve nature. A virtual reality framework of the future state of forest cover may be created to understand the complex shifts in climate-driven ecosystems (Hwang et al., 2020). Another powerful AI tool, Google Expeditions, provides virtual field trips (Tudor et al., 2018; Sermet & Demir, 2020). The learners can explore the Arctic, witness melting glaciers, dive into coral reefs to observe bleaching, visit deforested Amazon areas, or experience acid rain from their classrooms. These immersive experiences foster a deeper understanding of climate change, its causes, and effects. Teachers can facilitate the learning process relating to environmental concepts. AI personalises climate education experiences according to the learners' interactions and adjusts content accordingly (Hsu et al., 2013). AI can provide additional visualisations or explanations to help them understand the concept fully.

4.2. Leveraging AIPTEL in education for climate change

As educational institutions transition towards sustainable infrastructure using AIPTEL, their carbon footprints are reduced. AI can be leveraged in education to mitigate climate change.

4.2.1. Bridging Educational Inequities Caused by Climate Change

There are many places where traditional education is inaccessible. Such disparities are aggravated by climate change. Several segments of the population lack learning opportunities due to climate-related disasters such as floods, droughts, and wildfires. They may migrate to different locations because of economic conditions in search of jobs, food, and security. AIPTEL is a step towards bridging disparities in access to education. AIPTEL provides remote learning solutions and ensures that their education is not hindered, reducing educational inequality due to adverse circumstances. Therefore, AIPTEL is also a significant facilitator of the United Nations' Sustainable Development Goal 4 (SDG 4), which aims to ensure "quality education for all by 2030" (United Nations, 2015).

4.2.2. Reducing Environmental Footprints in Education

The traditional educational system model requires the physical presence of both learners and teachers on the campus. This makes it inevitable that these physical campuses be maintained in good condition. There are emissions related to operational costs of the buildings, transportation, and electricity consumption. That puts an enormous burden on the environment. AI technologies offer innovative solutions that can significantly reduce the carbon footprint of educational institutions. They help optimise electricity usage and other resources based on real-time occupancy and weather conditions. AI-powered infrastructure, also known as smart buildings, is energy-efficient because of automated lighting systems, temperature control, enhanced security features, and better air quality monitoring. AI also helps in predictive maintenance and reduces downtime-related costs. AI-powered energy management systems can significantly reduce inefficiencies and operating costs among educational institutions. AIPTEL enables the setting up of virtual classrooms, which offer a sustainable alternative to physical classrooms and help minimise environmental burden. It dramatically reduces the need to maintain large-scale infrastructure and hence reduces energy consumption. Apart from this, AI-enabled cloud-based platforms offer an innovative solution for storing and preserving large amounts of data; therefore, they significantly reduce the need for maintaining large data centres and operational costs associated with their maintenance (Schiff, 2021).

At the administrative level, AI helps streamline processes like automating administrative tasks. This will reduce overhead costs and the environmental impact of managing large educational systems (Hannan & Liu, 2023). By analysing data, AI, with the help of machine learning and natural language processing (NLP), aids in making financial and environmentally sustainable decisions (Furey & Martin, 2019). It also acts as a coordination tool to optimise resource allocation and ensure efficient asset utilisation. In the traditional education model, pen and paper are necessary, which generates paper waste and require printed textbooks, which, when outdated, necessitate new ones to be printed. This causes enormous amounts of carbon emissions and large-scale cutting of trees. AI-driven platforms digitise learning materials, reduce paper consumption, and enable real-time updates to minimise resource depletion. VR/AR tools further reduce the need for physical laboratory equipment and field trips, which helps lower transport-related emissions and costs. Material costs for constructing and maintaining laboratories are also reduced.

AIPTEL promotes environmental sustainability by facilitating remote assessments, online proctoring, and automated grading. Learners can take online exams from anywhere. AI tools make the process convenient and secure. Online assessments also reduce the need for paper printing and commuting. This reduces the carbon footprint of educational institutions. It also facilitates large-scale testing, where many learners can take the exam simultaneously. AI tools automatically grade multiple-choice and essay-type questions, ensuring prompt feedback for the learners and reducing teachers' workload. AI-based grading minimises biases as well as human errors. Answer sheets may be assessed remotely. Platforms like XProctor and ProctorU offer online exam proctoring services (Slusky, 2020). Real-time monitoring of exams is possible through webcams and microphones. This prevents cheating or using other unfair means in the examination (Nigam et al., 2021). AI tools can detect suspicious activities. AI tools monitor candidates during examinations through webcams. Any suspicious behaviour, like unusual eye movements or background noises, is flagged and alerts are generated for invigilators. Exams can be conducted remotely without compromising the integrity and credibility of the examination process. This results in a significant reduction in the carbon footprint of educational institutions. The need for transportation of question papers and answer sheets to examination centres is substantially reduced. The requirement for printing question papers and answer sheets has also been reduced. This is a step towards bringing sustainability to education.

5. Discussion

AIPTEL provides a robust framework for using AI in education and mitigating the climate crisis by aligning with SDG 4 (Quality education for all) and SDG 13 (Climate action). Enhancing climate awareness helps in reducing the carbon footprint of educational institutions. Thus, educational institutions must transform their existing infrastructure into AI-enabled infrastructure. This infrastructure modernisation must be accompanied by pedagogical innovation. There is a need for changes in the academic curriculum. The curricular changes involve integrating climate-focused content, taught with the help of AI-based models like simulations and gamification. Investments in green buildings, energy-efficient systems, and digital learning platforms must accompany these changes. Simultaneously aligning infrastructural and pedagogical reform will help raise an environmentally conscious population and sustainable education.

Although integrating AIPTEL into education to mitigate the climate crisis seems promising, it poses specific challenges. For example, AI technologies themselves consume a significant amount of energy. Second, some countries and educational institutions lack the infrastructure, resources, internet connectivity, and devices to integrate AIPTEL. Third, ethical concerns regarding data privacy, surveillance in AI-based proctoring, and logarithmic bias remain some of the most crucial inhibiting factors hindering the integration of AI in education. There is a need for transparent and ethical use of data. The successful implementation of AIPTEL depends on institutional readiness and government policies. To fully harness the potential of AIPTEL, the government must formulate supportive policies. Investment must be made in training teachers, curriculum redesign, and green infrastructure. Future studies must examine the long-term effects of AI-powered climate education on the environmental behaviour of learners, their level of ecological awareness, and the quantum of reduction in carbon footprint. AIPTEL signifies a strategic convergence of technology with pedagogy to promote sustainability. Despite challenges in its full-fledged implementation, it has the potential to transform climate change education and sustainability in the education sector. AIPTEL, with all its promises and challenges, can be a successful solution to mitigate the climate crisis.

6. Conclusion

Climate change remains one of humanity's most pressing existential threats, requiring urgent action from all stakeholders. A single nation cannot reverse climate change. Hence, concerted and collaborative efforts from governments, educational institutions, technology innovators, NGOS, and individuals are necessary to drive systemic change. AIPTEL can be a transformative approach in addressing the climate crisis by revolutionising climate education

through personalised learning, immersive simulations, and remotely accessible learning platforms. It can also help bring behavioural changes towards climate change, reduce educational inequities, and minimise carbon footprints. As climate change threatens ecological and social systems across borders, governments, academic institutions, technology providers, and civil society actors must collaborate in scaling AI-powered educational interventions. This technology, pedagogy, and sustainability nexus will not only be a tool in raising environmental awareness but also an essential strategy in ensuring a livable and equitable future for all.

Compliance with ethical standards

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